THE ENGINEER.

British Machine Tools at the Glasgow Exhibition.

BRITISH MACHINE TOOLS AT THE GLASGOW EXHIBITION.

No branch of engineering shows to greater advantage at the Glasgow Exhibition than the manufacture of machine tools. Not only are the British, and particularly the Scottish makers well represented, but the principal importing firms exhibit excellent and varied collections of foreign tools—principally American. Indeed, presumably from the nature of the case, the merchants are able to carry off the palm both in the matter of space occupied and variety. The fact that they show machines manufactured by many different companies is sufficient to account for this fact. In the present Supplement we propose to consider only machine tools manufactured in the British Isles, but on future occasions we shall select for description from the numerous foreign-made tools such as we think will be found of greatest interest by our readers.

As we have said on a former occasion, the machine tool trade of Great Britain is well represented in spite of the absence of many firms whose work we should like to have seen exhibited. It would be invidious to mention names, but there are more than one Yorkshire firms of world-wide reputation whose participation in the Exhibition could only have added to its honour and to that of the country. There is a notion current about Yorkshire tools which needs combating. That can be done in no way more effectively than by public displays.

As might be expected, Scotland, and particularly the district immediately around Glasgow, occupies a large share of this section, over one-third of the exhibitors having their works over the border. The work they show is without exception of as high a class as we should expect in a district so celebrated in the annals of mechanical engineering.

In striking novelties the Exhibition is not rich, for, although a few tools are publicly exhibited in this country for the first time, they are no longer new to those who follow the progress of this branch of engineering. The Americans have as little that is really novel to show as the British exhibitors. They exhibit a few new tools for the first time, but it seems not infrequently as if the novelty had been designed more with a view to producing something a little different to what others make than with a belief that any greater economy or efficiency is to be expected from the new machines. The tendency of novelties of this order—we might indeed say of most novelties—in machine tools at present leads in the direction of further complication. Now, we do not for a moment doubt that the superior intelligence of the modern workman about which we hear so much, and the increased accuracy of manufacture, do a great deal to render the multiplication of parts less offensive than it would have been some years ago. At the same time it is not to be denied that simplicity and directness are always worth striving for, perhaps for making sacrifices to obtain. The fashion has set in for instantaneous reversing gears, for rapid feed changes, for screw-cutting trains, and so on, and the makers have to supply them, but there are many amongst them who, whilst providing what they are expected to provide, protest against complications of which the advantage seems hardly worth the candle. The gain of time, for example, which is to be realised by special change gears for screwing or by the complicated devices affected in some milling machines, appears to be altogether disproportionate to the extra expense and intricacy of the machine. It is hardly conceivable that the general work of a shop can demand such frequent modifications of feed and speed as these devices would require to make them of great economic importance, and it is difficult to believe that with modern methods of manufacture a manager will not contrive, as far as possible, to obviate the demand for frequent changes. However, this is a subject into which it would be unsafe to enter at the present moment. Our object is to put before our readers a description of the machine tools exhibited; it is for them to select those that seem best suited for their purposes. We have, before commencing that part of our work, two things to say. One is to express regret that the authorities of the

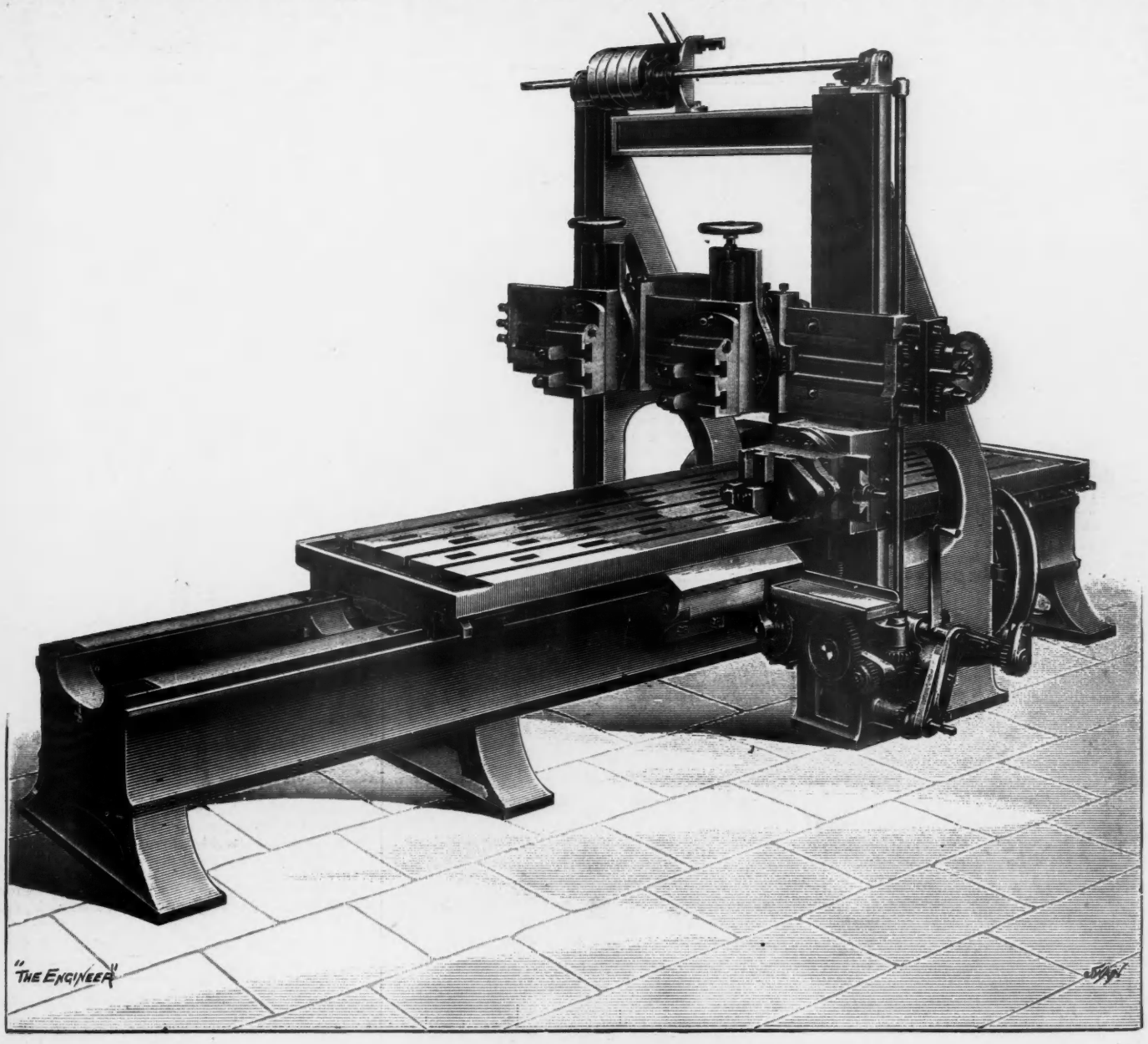


Fig. 1—PLANING MACHINE BY SHARP, STEWART, AND CO., LTD.

Exhibition have not taken some steps to keep down the temperature of a building roofed with iron and glass, as formidable combination as one could conceive; and the other is to again suggest that makers would have nothing to lose and everything to gain by letting us have drawings of their machines for publication. It will be only fair, we think, in this connection, to mention the names of Alfred Herbert, Limited, Coventry, who very kindly, as on former occasions, put in our hands a complete set of working drawings of a fine machine—some of them are reproduced later—and of Sharp, Stewart, and Co. and the Carron Company, who have provided us with drawings of particular details. We feel sure that these drawings will bring home to users the value of the tools to which they apply far more forcibly than mere photographs and descriptions. We hope, in time, to induce not only machine tool makers, but other engineers, to see the value of making the details of their machinery as widely known as possible, and we hope, in time, to encourage them to discuss them freely and openly in our columns. We have heard of no evil results accruing from this practice on the Continent or in America. Why should they in Great Britain?

No special plan has been adopted in the following pages; the arrangement has been followed which best suited the convenience of editing.

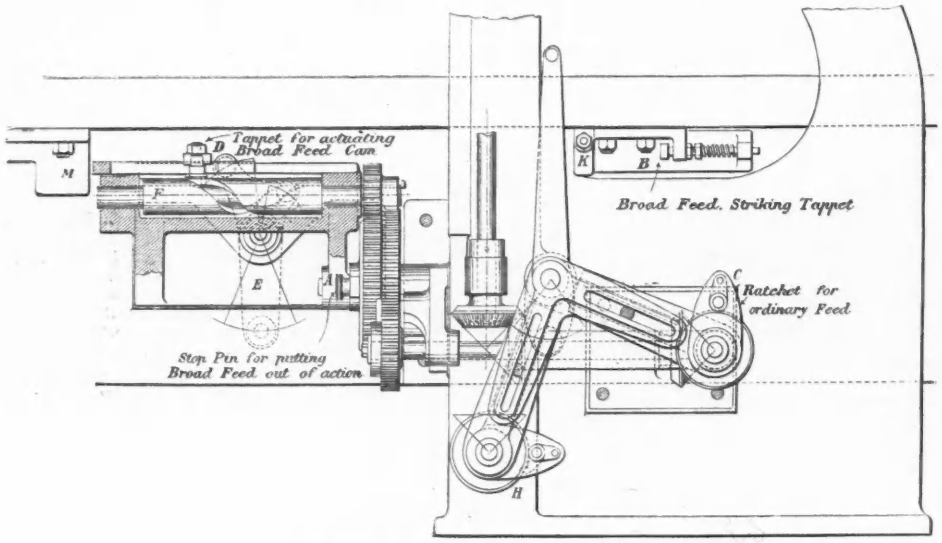


Fig. 2—FEED GEAR FOR PLANING MACHINE

SHARP, STEWART, AND CO., LIMITED.

One of the most notable collections of machine tools in the Exhibition is that made by Sharp, Stewart, and Co., Limited. For the greater part the machines are of fairly large size, and their proportions have a kind of satisfying look to British managers, who particularly favour a tool which may be worked all day and all night long, year in and year out, up to its maximum capacity, without showing undue signs of distress. Several of these machines we illustrate. On the preceding page we give an engraving, Fig. 1, of a fine 10ft. by 4ft. by 4ft. planing machine, shown by this firm. It is driven by Sellers gear, and runs at an unusually high speed. The first apparent feature in which it differs from the majority of planing machines is in the use of flat slides in place of the usual vees. We do not know that there is much in this. With fair use the bed of any good British planing machine is practically indestructible. The particular form in which it is made is of comparatively little consequence, as long as there is ample surface, and as long as proper provision is made for preventing side play. The weight of the table and the work are generally found sufficient to prevent any rise up the inclines in a well-designed vee bed; possibly the unequal-sided vee gives a certain amount of advantage in presenting a side so steep that no conceivable side pressure could lift the table. The square bed gets over the question altogether by presenting a vertical plane to side thrust, which seems the proper mechanical way of taking it, but in doing it the automatic adjustment is done away with. However, as we have said, the wear is so very small that the particular form is of little consequence.

Driving by Sellers gear is another matter. It consists, as probably most of our readers are aware, in using a worm to drive a rack. The worm is mounted on a shaft, which crosses the rack at an angle of about 30 to 35 deg.; the teeth of the rack are square across. For fast and heavy driving it gives a steadier motion with less play than a pinion, and on that account has been adopted by several machine tool makers in this country. It has, of course, the usual disadvantages of a worm-driven rack—greater friction and less surface, but these are more than compensated for in particular instances. In the machine before us, for example, the table cuts at 25ft. a minute, and returns at 130, and it is doubtful if the ordinary gear could be made to work at that speed satisfactorily. The usual ratio of cut to return does not exceed ½, and 20ft. is the usual maximum cutting speed. It is contended by some makers that this speed and ratio give the greatest efficiency. It would be interesting to know the power consumed per pound of metal removed by this machine, and the maximum required at the instant of reversal. It may be noted that this exceptionally high speed is not generally adopted by the makers, 22ft. cutting and 125ft. return being their usual practice for this size of machine.

To resume our description, the driving wheel of the Sellers gear is enclosed in a case, which is seen projecting to the right of the forward standard in the picture. It is driven by a machine-cut raw hide bevel pinion on a shaft, which passes through the bed, and carries the drive pulleys on the opposite side.

There are two feed motions, the ordinary $\frac{1}{32}$in. to $\frac{1}{8}$in. and a special broad feed made under Robinson and Oldfield's patent. Both these gears are better shown in the drawing above, Fig. 2. The ratchet C is used for ordinary feeds. Its connection with the vertical feed shaft by bevel gearing is clearly shown. The amount of feed is regulated by the position of the pins in the slots in the bell-crank lever. The lever for actuating it is shown dotted at E. This lever E also actuates the reverse. The ratchet wheel H is for the feed of the side tool box shown in the engraving. For the broad feed, which will give up to 1½in., a spiral cam F is used, and is connected by a train of gear, which includes a ratchet, with the feed shaft. The pin D, which works in the cam is mounted in a slide, and is struck by the tappet B at the end of the return stroke of the table. D is moved back in readiness for the next stroke by the lug K, which is only free to swing in one direction. M is the striker for the reversing gear. The amount of the feed is changed by altering the position of D in the slide, so that more or less of the spiral is used. A little clutch at A provides for throwing the broad feed out when desired. The device is pretty, and appears to have been thought out with a good deal of care.

In sharp contrast to the greater number of turret lathes which are to be seen at the Exhibition, and which, as a rule, bear many marks of relationship with American designs, is Mr. Geo. Oldfield's lathe shown by Sharp, Stewart, and Co., Limited. It is an essentially British tool, a machine proportioned on the most generous lines, and intended to face the heavy feeds which characterise machine shop practice in this country. The engraving which we give above, Fig. 3, will make this point clearer than many words. The objects which Mr. Oldfield had before him in getting out this design were, first, to so arrange the tools that they could be brought close up to the chuck, at the same time being well supported; secondly, to permit of both the turrets being brought into action together; and, thirdly, to provide a separate screwing head which would return automatically to position for a new cut after each passage of the dies. The machine is, in a sense, semi-automatic, but it is supposed to occupy the whole attention of one operator. It is a heavy machine, intended to deal with 2½in. merchant stock, but to provide for the irregularities in diameter which are always found in black bar, the chuck

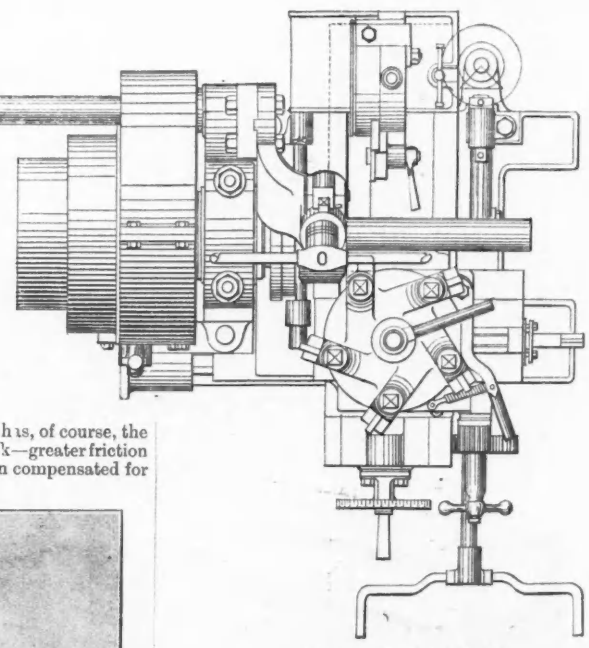


Fig. 4—PLAN OF SADDLE

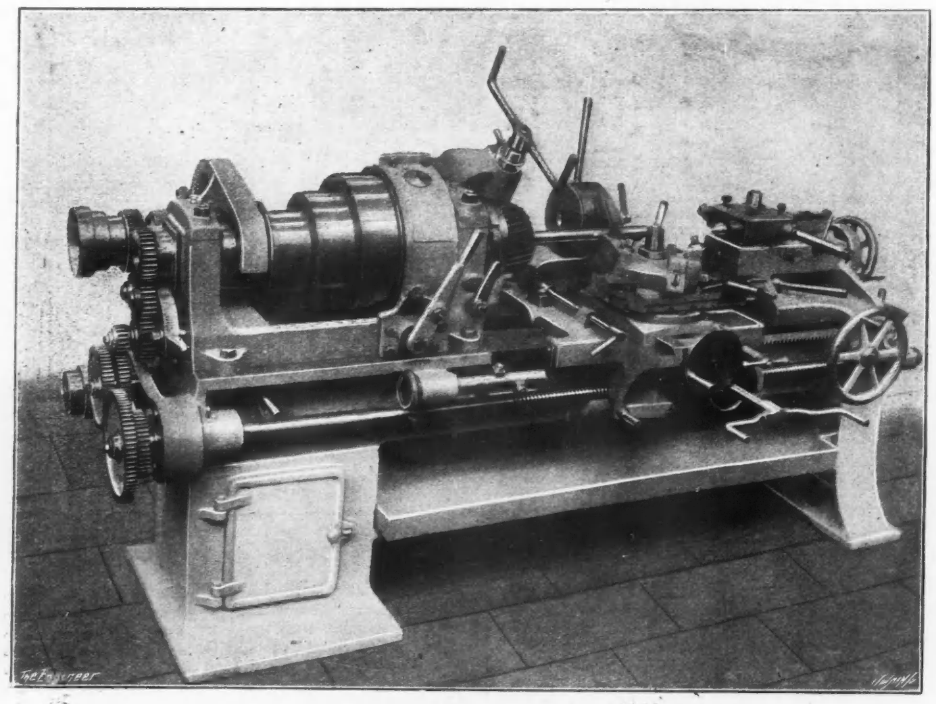


Fig. 3—OLDFIELD'S TURRET LATHE

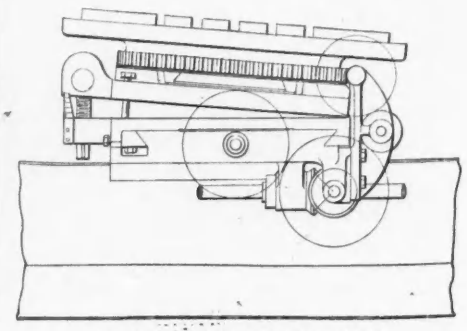


Fig. 5—SLOTTING MACHINE TABLE

will take up to 2⅜in. This chuck and the provision for tightening it, by means of a cross handle and slow pitch worm, are clearly shown in the engraving. The worm spindle passes through an excentric bush, by which means it is thrown in and out of gear as desired. The turret or capstan on the saddle demands principal attention. It is of a simple design, and is intended to take plain rectangular tools sharpened in an easy manner. It is shown in plan on the previous page, Fig. 4, which, with the help of the engraving, will make the form quite clear. It consists of a casting in which five rectangular pockets are formed. Each of these pockets is adapted to receive a single tool, and they are so inclined at an angle of 14 deg. upwards that the necessary top rake is given without special grinding. The tools are set by running them out till the cutting edge is at the desired level, and thus no packing is required. The turret is so arranged that when clamped in position, the tool-holder or pocket nearest the head is at right angles to the lathe centres, and thus the tool is brought very close up to the chuck, see Fig. 4. The tool is supported underneath by a sort of projecting lip so that the overhang is exceedingly small. This turret is revolved by hand and fixed by a lever engaging notches in its side and a clamping screw. On the saddle, which, by the way, calls for no particular remark in other respects, there is also mounted a screwing head which is brought into position by cross-traversing the slide. It contains the screw-cutting dies, which can be adjusted by a lever and scale to take as large a cut as may be desired at a time. This head moves on a slide parallel to the centres and draws itself up for small screw cutting, but for heavy work it is clamped to the saddle and fed up by the lead screw. In the former case a spring returns it to position for a fresh cut as soon as the dies are released. The back poppet is modified to receive a square turret mounted on a slide. It can be racked along as a whole by the hand wheel seen in front, or fed forward on its slide either by hand or automatically. From the position which the tools occupy the centre of the turret falls behind the centre line o the lathe; this gives the advantage that the square turret clears the turning turret, and, consequently, boring and turning can be carried on simultaneously under all conditions. Apart from its particular features this fine tool calls for no special description. The back gear can be thrown in instantly. The open gear clutch is frictional, the back gear clutch positive. The feeds and speeds provided for are as follows:—Turning, speed 35ft. circumferential per minute; screwing, 7ft. per minute; the feeds of the turning turret, 12, 16, 23, 32, 44, and 62 per inch; of the boring capstan, 55, 76, 107, 152, 213, and 299 per inch. These feeds are entirely independent of the lead screw, which is only used for screw-cutting. Cut wheels are used throughout. The change from roughing to finishing feed, either turning or boring, is made instantaneously. Hand set stops are provided in both directions.

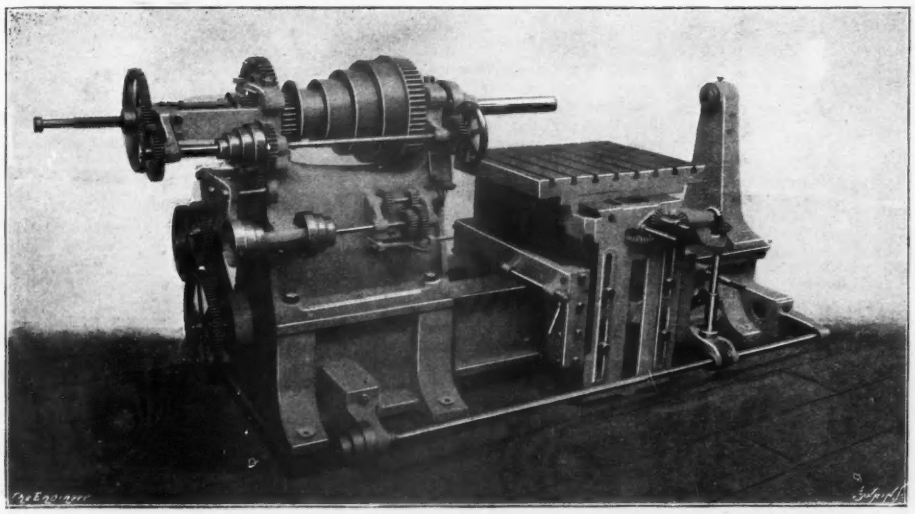


Fig. 6—HORIZONTAL BORING AND MILLING MACHINE BY SHARP, STEWART, AND CO., LIMITED

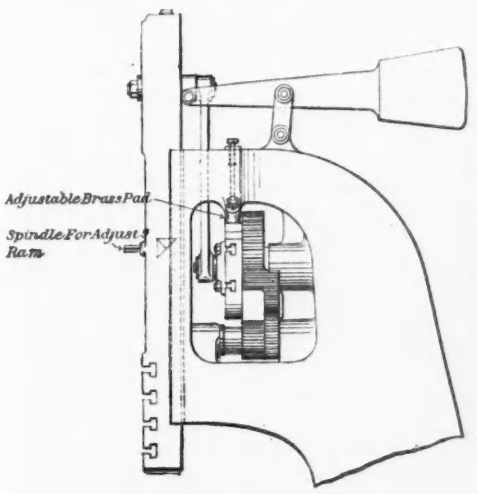


Fig. 7—SLOTTING MACHINE HEAD

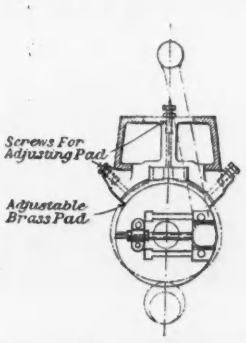


Fig. 8—ADJUSTING PAD FOR SLOTTING MACHINE

A powerful slotting machine with 16in. stroke is also shown on this stand. It does not differ in general appearnace from many machines of its type. It is, however, provided with elliptical gearing, not very common now-a-days, and is provided with a thrust pad above the crank disc to take the pressure against the tool. This is shown in detail in Figs. 7 and 8, and is a feature worth noticing. This drawing also shows the elliptical gear. The driving spindle carries a broad driving pinion and a narrower elliptical pinion for the return. By this arrangement the cut is made at constant speed, the elliptical pinion only coming into gear for the return. The step cone is mounted in a bracket at the back of the column. A good point is the addition of a large hand wheel, by which the machine can be turned for adjusting the stroke, &c., a method which is far preferable to the usual practice of pulling the belt. The table, besides having self-acting motions in two directions and rotation, can also be inclined for slotting taper work without interfering with any of its other motions. An index is fitted for showing the degree of indication. Fig. 5 shows the side elevation of this table. The drive is through two changes, giving six speeds in all. Cut gears are used throughout.

A triple-geared self-acting lathe is also contributed by this firm. It represents a class of work to which Sharp, Stewart, and Co., Limited, have devoted a great deal of attention, and is a fine specimen of the heavy machine tool maker's work. The height of the centres is 27in., the length of the bed 18ft., but provision is made for lengthening it up to any desired amount; it admits 8ft. 2in. between centres. The saddle carries two rests, one at the back simple, the other full compound, with swivelling table, &c. The face plate is keyed to an independent spindle, and driven by a pinion on the cone spindle and internal gear. Provision is made for screw cutting, the leader being within the bed; a rack is used for sliding, and reversing gear is fitted to the feed shaft. The back centre can be set over for taper work, and can be racked along the bed. The automatic feeds for turning are taken through the lead screws and change wheels, but for cross cutting an independent set of change wheels is employed, the guide screw not being used. The incutting feeds provided for are 8, 12, 18, and 24 per inch.

A fine horizontal boring and drilling machine, suitable also for screw cutting and milling shown by this firm is illustrated above, Fig. 6. The diameter of the spindle is 3½in., the length of the bed 11ft. 4in. The machine will bore up to 24in. diameter, by 3ft. 6in. long. The feed of the spindle is obtained by a screw seen projecting from the back. The nut for moving it is keyed in the boss of a spur wheel, which is driven by another wheel on a spindle revolved by worm gearing. The cone shown on this spindle is not keyed to it, but is driven from the spindle by tooth wheels, and drives by a strap the countershaft below it. This is provided with gear for doubling the rate of feed instantaneously. A second cone pulley on this shaft drives the table feed shaft near the ground. The table has self-acting motions longitudinally, transversely, and vertically, and can be moved along the bed, either by a rack or by a leader, for screw cutting. The spindle has six automatic feeds, viz., 24, 36, 48, 57, 74, and 115 revolutions per inch travel; the transverse slide on the table has automatic feeds for milling and surfacing as follows:—¼in., $\frac{3}{16}$in., $\frac{5}{16}$in., $\frac{7}{16}$in., ½in., and 1in. per minute. The automatic feeds for the table being taken from the lead screw and change wheels cover a very wide range. It will be observed that all the operating handles are close

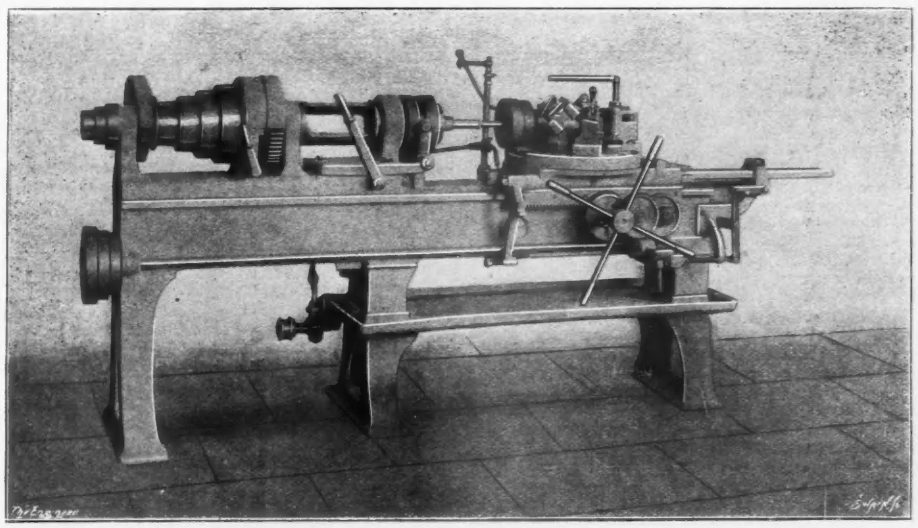


Fig. 9—FLAT TURRET LATHE BY SMITH AND COVENTRY

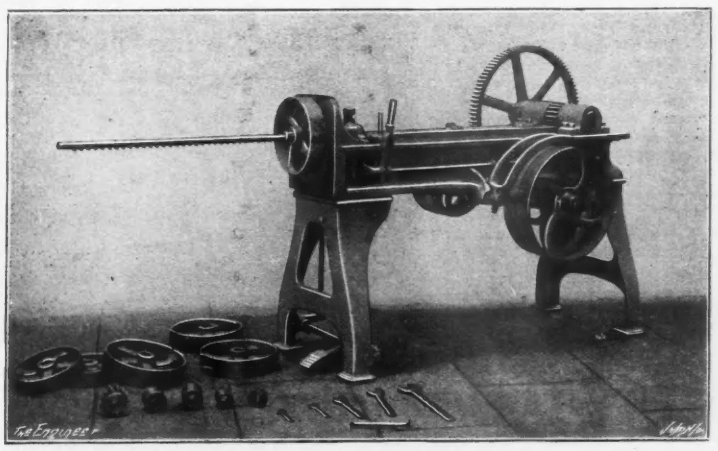


Fig. 10—KEY-WAY CUTTING MACHINE

together, so that the workmen has them well under control. The engraving brings out clearly several points which it is unnecessary to mention.

There is no collection of machine tools at the Exhibition which displays more fully the characteristics which have made British machines famous for their strength and endurance the world over than this fine stand of Sharp, Stewart, and Co., Limited.

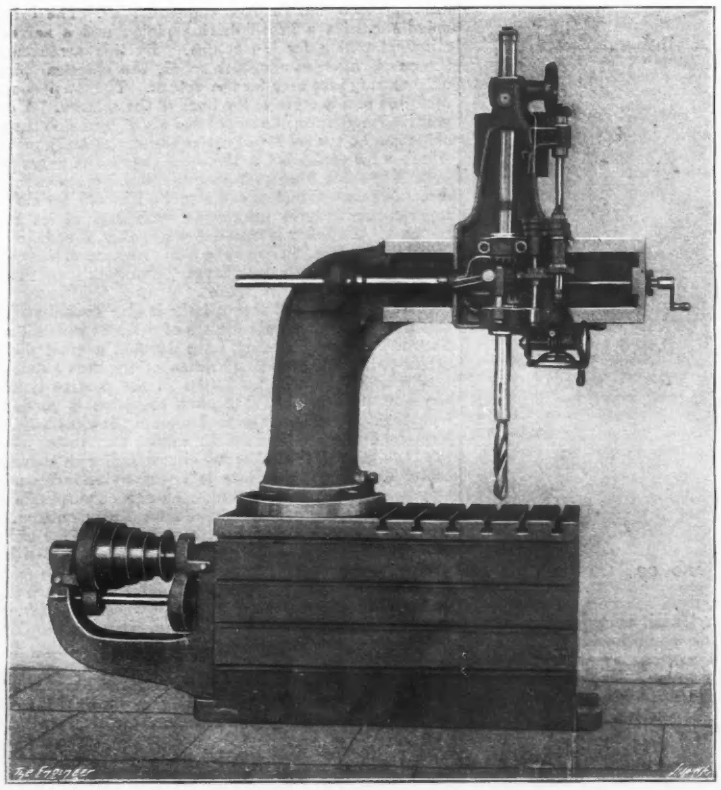


Fig. 11—RADIAL DRILLING AND TAPPING MACHINE

SMITH AND COVENTRY.

One of the machine tools which is attracting considerable attention at the Exhibition is the bevel gear planing machine lately introduced by Smith and Coventry, and described in detail, with drawings, in our issue of August 24th, 1900. This machine was exhibited at Paris, and was very highly considered by the judges. Our description showed an improved form to that sent to Paris, and in the Glasgow machine one or two further modifications have been effected. The principal improvement is the provision of a separate wheel for dividing or indexing from that used for rotating the blank. The necessity for this is open to question—a little sentimental, perhaps—but to meet the views of some purchasers of the machine it has been effected in a very simple manner. Furthermore, to facilitate the use of the machine—or, rather, to avoid an occasional difficulty—a curved slot is provided in place of the fixed pin in the rocking arm. This permits of such adjustment being made that a dead centre need never occur. These observations will appeal to those who have studied the machine closely or who have it in use; to those who are not well acquainted with it we fear they will be scarcely comprehensible. We are glad to hear that this tool is meeting with considerable success.

We have another machine on this stand which is to be regarded to a certain extent as a challenge to American makers. This is the flat-turret lathe illustrated in Fig. 9. It is the first machine of this type made, and Smith and Coventry candidly admit that certain improvements are to be made. These improvements are to be in the right direction—that is to say, they will, it is believed, further simplify and cheapen the machine. It will be noticed that the lathe is of very simple construction. It has a hollow spindle with a large opening to allow stock to be drawn forward by hand, or to permit of the insertion of such things as bolts through the chuck from the back. The chuck is of simple description, worked by a lever, and is sufficiently adjustable to accommodate it to the irregularity of black bars. The headstock has friction back gear. The chief interest centres in the saddle and turret. In nearly all lathes of this sort there is a fixed rack on the bed, and a train of wheels concealed in an apron. Smith and Coventry have departed from this custom and have fastened the rack on the saddle, putting all the wheels, cross handle, &c., on the bed, thus reducing the weight of the saddle as a whole. The wheels are shown in the engraving, and at the Exhibition, but it is the intention to cover them. To draw the tools back from the work and revolve the turret automatically the cross handle is used; to feed the tools forward the front shaft drives a worm which can be lifted up into gear with a wheel in the train. This is shown clearly in the photograph. The stop bars for the travel of the saddle release this worm at the right moment and stop the feed. The length of stock is adjusted by a swinging arm pivoted on the front end of the saddle; it is shown hanging down in the engraving. The turret is of the flat type and the cutting-edge of the tools is within the point of support. Different forms of tool boxes to suit the work in hand may be fitted. For finishing bolts and spindles, on which the machine is engaged at the Exhibition, the tools are—a turner reducing the bar to the diameter at one operation, a self-acting die-box for screwing, an ending tool, and a cutting-off tool. The latter is fed up against the work by a rack and lever, shown. The die-box pulls the whole saddle along, and opens automatically at the desired point. Inverted vees are used on the bed because it is found that the saddle slides easily on them, and this is important when cutting with dies in this way. The stops used are of the well-known hook and notched bar form. The bars are all clamped in the bracket at the end, and act on the feed worm through the combination of levers shown. The position at which the rotation of the turret takes place can be adjusted by merely turning a large knurled knob indistinctly seen on the front of the bed in the engraving. It does not involve any alteration of the stops. A pump for lubrication is provided.

Two speeds, or direct and reverse running, are obtained in the usual way from the countershaft. This machine appears to be a step in the direction of meeting the demand for a turret lathe, having the principal characteristics of the best modern practice, but at once more simple and less costly.

We illustrate also—Fig. 10—a rapid key-way cutting machine, shown by Smith and Coventry. The idea is simply to draw a suitable form of drift through the boss of the wheel or whatever it may be, and so cut the key-way at one operation. The drift, it will be observed, is very long, and the cut increases until it reaches the desired depth at the extreme end of the bar. The cutting tools are pieces of steel some few inches long with several deep notches milled out of them. They are fixed in a channel in the cutter bar. Only the extreme tops of the teeth are ground. The bar is clamped to a rack, which is pulled through the machine by powerful gearing. The wheels to be operated on are pushed one at a time on to a suitable size of excentric bush. If a taper key-way is required, the bush is simply inclined a little upwards, special provision being made for the purpose. It will be readily understood that this machine works with great rapidity. We are informed that 140 key-ways 2½ long by ⅜ wide by $\frac{5}{16}$ deep, have been cut in one hour, and we see no reason to doubt the statement.

Another machine which tends towards simplification is a radial drilling and tapping machine, illustrated by Fig. 10, which leaves little to be said in the way of description. The machine will drill up to 3ft. 6in. radius, and will admit 1ft. 11in. over the box bed, and 4ft. 2in. at either side, that is clear of the bed. It will drill a 2in. hole out of the solid, or bore a 4in. hole with bar and cutter. The travel of the spindle is 15in. The feed is effected by hand or power through a rack on the spindle sleeve. Three positive changes of power feed can be given by a sliding feather in the usual way, and an instantaneous reversing clutch for tapping is fitted. By throwing this clutch half way the spindle is stopped.

Besides those we illustrate, Smith and Coventry exhibit several other tools. These include a powerful vertical milling and copying machine, similar to that exhibited by them at Paris and illustrated in THE ENGINEER of August 24th, 1900; a 5ft. radial drilling and tapping machine with balanced spindle, the saddle of which closely resembles that of the smaller machine illustrated above, it is, however, traversed by means of a rack instead of a screw; a well-proportioned universal cutter grinding machine; and a small side planer with two tables and one head. The stand is neatly arranged, and the machines are all painted an effective grey tint. Through a misunderstanding of the exhibition regulations, Smith and Coventry did not provide their stand with overhead gear and their tools are driven by electro motors fastened to the ground. One of these is mounted on a special stand which appears incidentally to offer a very convenient method of driving one or two tools from a motor in position where difficulties would be experienced in providing the usual countershafts.

THOMAS SHANKS AND CO.

One of the most striking of the exhibits of machine tools in the Machinery Hall is that of Thomas Shanks and Co. The space occupied is large in comparison to that taken by most of the other manufacturing firms, and the tools shown are among the largest in the Exhibition. It is unnecessary to comment on their construction. The quality of the workmanship, and the excellence of the designs of tools made by this firm, are too widely known to require our commendation. We have selected for illustration the three largest machines on this stand. These are illustrated below and on the next pages. The engraving on page v. shows a powerful self-contained vertical and horizontal planing machine. It has a base 12ft. 9in. long by 9ft. 1½in. wide, and 12½in. deep. The extreme height is 14ft. 4in. It will plane horizontally a length of 9ft., and vertically a height of 7ft. It is thus a fairly large machine, although it is classed by its makers as of "moderate size." The illustration, to a large extent, tells its own tale. The front of the bed is quite clear, which allows of the setting of work which would otherwise require the use of a very much larger machine. The double motion permits of the planing of faces at right angles to each other, while an in-cutting slide with two bars of different lengths fitted with interchangeable steel relief boxes provide for work which would otherwise be inaccessible. This slide box, it should be observed, has a serrated face, which, meshing with similar serrations on the tool bars, provides a means of holding the latter very securely. The main saddle is guided by two horizontal slides, the lower of which is sufficiently raised to allow

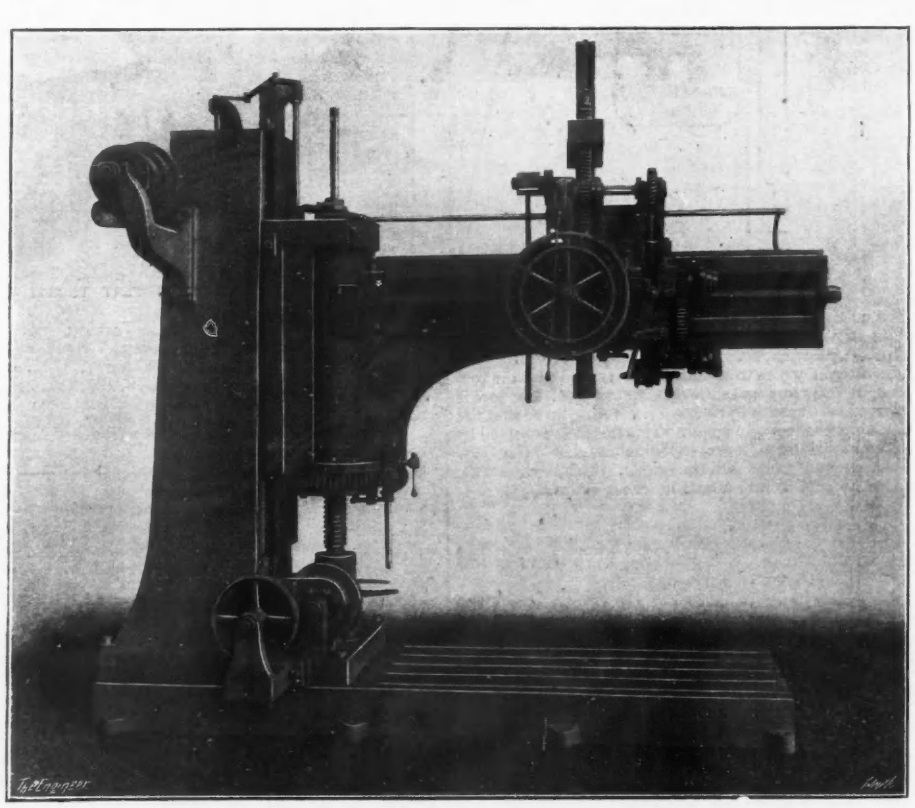
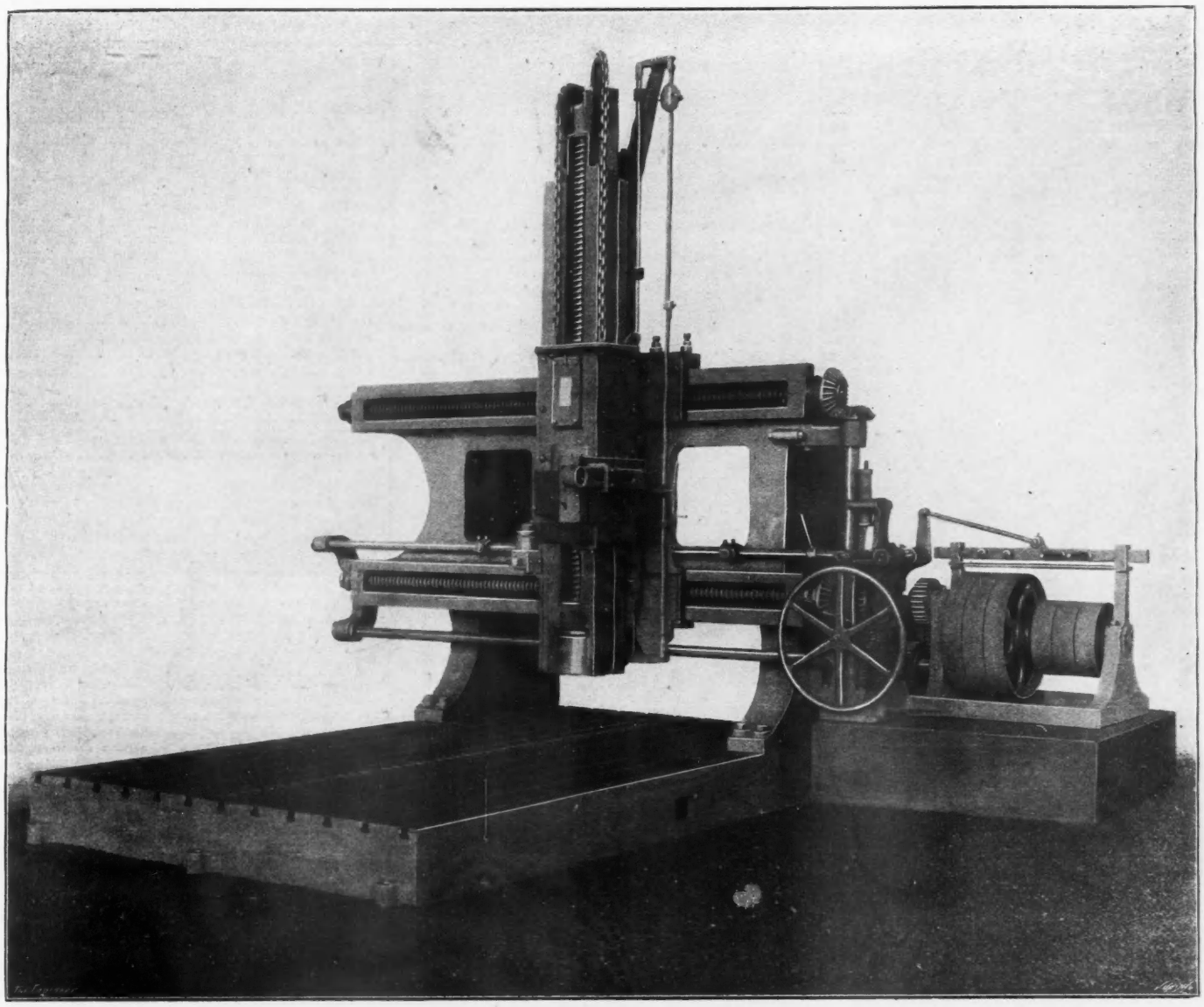


Fig. 12—RADIAL DRILLING MACHINE, BY THOMAS SHANKS AND CO

VERTICAL AND HORIZONTAL PLANING MACHINE

THOMAS SHANKS AND CO., JOHNSTONE, ENGINEERS



work of moderate depth to pass underneath it, and the vertical saddle is made of such a length that the tool can be brought down close to the base. The planing motion is effected by two horizontal screws, the slotting motion is by one vertical screw. Full reversing motion for shifting the belt for quick return is provided. The ratio of speeds is from 2½ to three to one. Automatic feed is provided for both these motions, and also for the in-cutting slide, but no broad feed is included, as it is claimed that the workman can put this on by hand to any practicable amount.

Another fine tool which figures on this stand is the slotting machine shown on page vi. It bears a considerable resemblance to that made by Sharp, Stewart, and Co., and already described, having a somewhat similar thrust pad and a-quick return motion of the same kind, giving a ratio of two to one. The stroke of the machine exhibited is 21in., but two larger and four smaller sizes are made. The height of the column is 9ft. 6½in., and the length of its base nearly 9ft. The diameter of the table is 50in. The mechanism of the machine is pretty clearly shown by the engraving, but attention may be called to the position of the operating handles, all to one side, and to the fact that variable elliptical feed has been substituted for the usual cam feed. The table has self-acting motion transversely and longitudinally, the latter commanded by two screws, and also rotary motion by worm and wheel.

The circular table is provided with a water trough. This machine has been designed for the execution of very accurate work, and the length of bearings and their width give every promise of such being attained.

We illustrate also, Fig. 12, page iv., a radial drilling machine with 3in. spindle, and a maximum radius of 7ft. The greatest height of the spindle from the base plate is also 7ft., and the vertical adjustment of the arm is 2ft. 9in. The base plate is 11ft. long by 3½ft. wide. The arm is raised by a tubular screw, through the centre of which passes the driving shaft. This shaft is driven by bevel gear and two purchases of spur gear; the drilling spindle can be stopped, started, and reversed with either purchase in a few seconds, which gives it advantages for tapping holes and driving studs. The spindle can also, of course, be disengaged, and raised or lowered by hand. The arm can be swung round by ratchet and worm, or freely by hand. The gearing and general appearance of the machine are shown well by the engraving.

A machine to which Thos. Shanks and Co. are inviting particular attention is a grindstone fitted with refinements for grinding tools at correct angles, and so on. The stone is run at high velocity, and the discs extend to within 5in. or 6in. of the edge, that is, allowing only the part which it is intended shall be worn away to project. The wheel is mounted in a large cast iron box, which stands in a cast iron tray. It has two large pockets in which the abraded material collects, and from which it is removed through mud holes. The town water supply is intended to be used, and it impinges on the stone from below. In cases where this is impracticable a water tank can be stood upon a flat-topped hood, which covers the stone. Both sides of the stone are to be used, but the out-running side only is provided with slides, &c., for holding, adjusting, and moving the tools; on the other side a rest for hand grinding is fitted. Provision is made for the use of a truing diamond, with which the stone can be rapidly corrected. It is the intention that this should be used three times a day. The stone is, approximately, 36in. diameter.

Some very interesting lathes, which we should have illustrated had we more space at our disposal, are also to be seen here. Two of these are called apprentice lathes, and represent a series which this firm is now constructing. Of these some are plain, and the others are vertical turret lathes. Both types are represented. For a description we cannot do better than quote that given officially by the makers:—

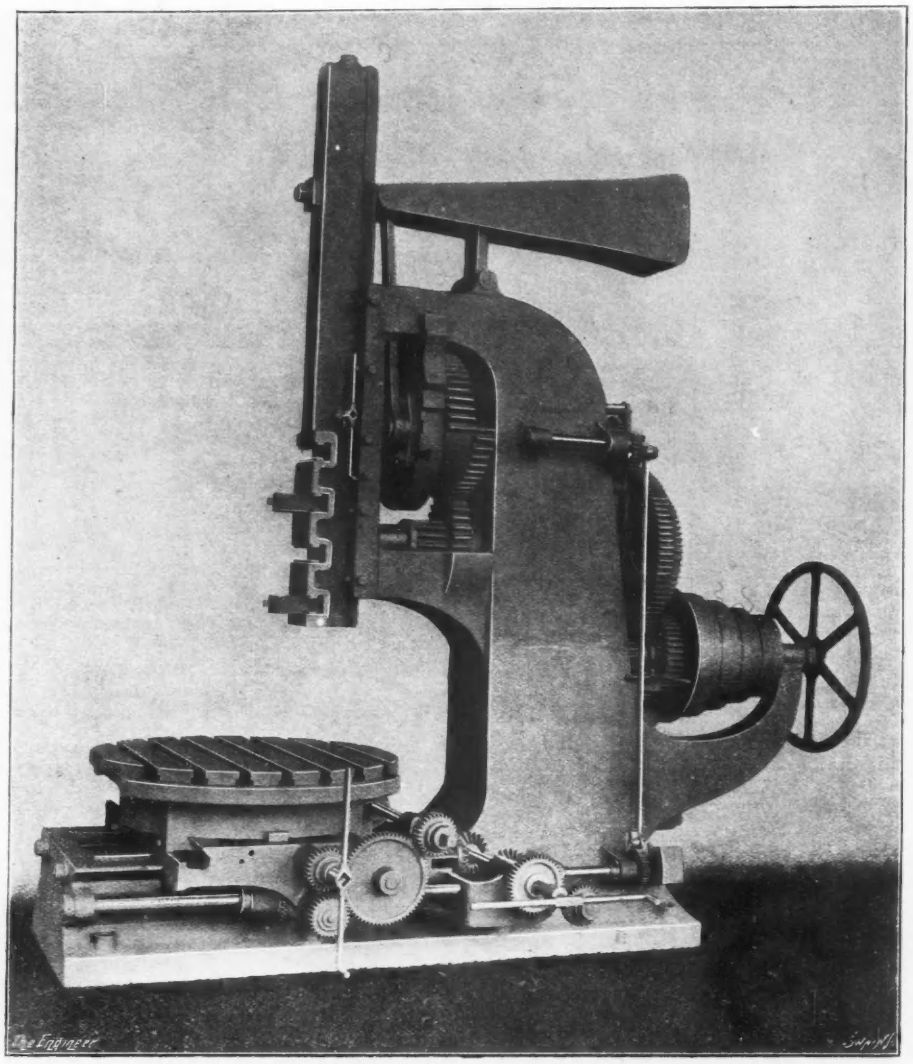
Any lathe is considered good enough for an apprentice turner, and the result is that the work they turn out costs as much for actual wages as if done by a journeyman, whilst the quality is much below the average. This fact, borne out by our own experience, has led us to make four types of lathes, which we have called the apprentice lathe. The feed motion is obtained from a guide screw. There are no change wheels or details for screw cutting, it being considered that after two or three years the apprentice can then be put permanently to a complete slide and screw-cutting lathe, and the apprentice lathe is therefore confined to face-plate work, mandril work, and short sliding work, all having the common feature—for strength—of casting the headstock and a short bed together, each lathe independent in its strains, so that one lathe may be roughing and its neighbour finishing without injury, which cannot be the case with a lot of hand lathes on a long bed. A further feature of the apprentice lathe is that the sliding and surfacing are not only self-acting in four useful and comprehensive grades, but they are engaged and disengaged instantly, leaving the hand motion at once in position. Many points of special value for apprentices may be noted. The V slides are substantial, and fitted with stop details. The swivel rest screw is clear of the loose head by the use of two small wrought iron pinions, and the rest set at any angle by one screw. The travelling stay requires no bushes and is universal. The loose head is very strong, is bolted from the top, has cross adjustment for taper, and the spindle is specially supported at the back. The driving headstock is of two classes, one with hollow mandril and simple double-purchase gear, and the other for the large sizes as complete as possible, with very large cones and double gear of two purchases. This form is for mandril and face-plate work of the largest diameter which will clear the saddle or the bed for face-plate work.

Another type is for rod and stud work, chamfering nuts and bolt heads and general work, and has the headstock and bed cast together. The steel mandril is fitted in gun-metal bearings with caps, with an annular tail pin of special detail. It is driven by three-speed cone and double purchase of machine-cut single gear. The slide bed is fitted with a strong saddle, with hand traverse, guide screw, and disengaging nut—not screw cutting—with four speeds of sliding traverse; internal surfacing slide with bottom swivel rest, and short slide for cone work, upon which is mounted a steel revolving multiple tool-holder with circular adjustment to bring each tool to the exact centre, where it can then be made perfectly rigid. The smallest size is surfacing by hand, but the others have four speeds of surfacing self-acting. The loose headstock is special for travelling stay work, and has a cross adjustment for taper work. The hollow mandril is fitted with a concentric chuck to grip any diameter to size, specially good for the inside of bolts, and chamfering and cutting down the head. Large bolts can be dealt with between centres, and driven by the chuck.

These lathes are of simple but very sturdy design, and being free from all complications, appear to be

SLOTTING MACHINE

THOMAS SHANKS AND CO., JOHNSTONE, ENGINEERS



particularly well adapted for apprentices' use, or for a good deal of the one-machine one-operation class of work.

JOHN HOLROYD, AND CO., LIMITED.

The Liebert screw milling machine has almost passed the stage when it is to be regarded as a novelty, but it has not been before the public long, and doubtless many people will see it in operation for the first time at the Glasgow Exhibition. It is made by John Holroyd and Co., Limited, Milnrow, in three sizes, all of which are shown. We illustrate the largest and the smallest. The latter is an entirely new machine, but the former, like No. 2, is already at work in several places, and seems to have found particular favour for the production of armour plate screws. The principle is as simple as could be desired. It consists in giving the bar to be screwed a motion of rotation and a forward translation equal to the pitch of the desired screw, at the same time allowing a milling cutter of the desired shape to produce the particular form of screw thread desired, and inclined at the proper angle to suit the pitch to operate on it.

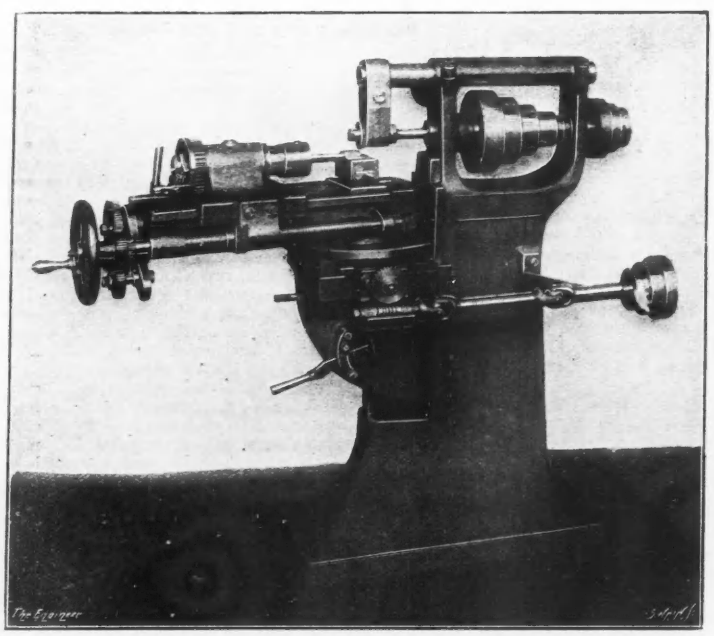
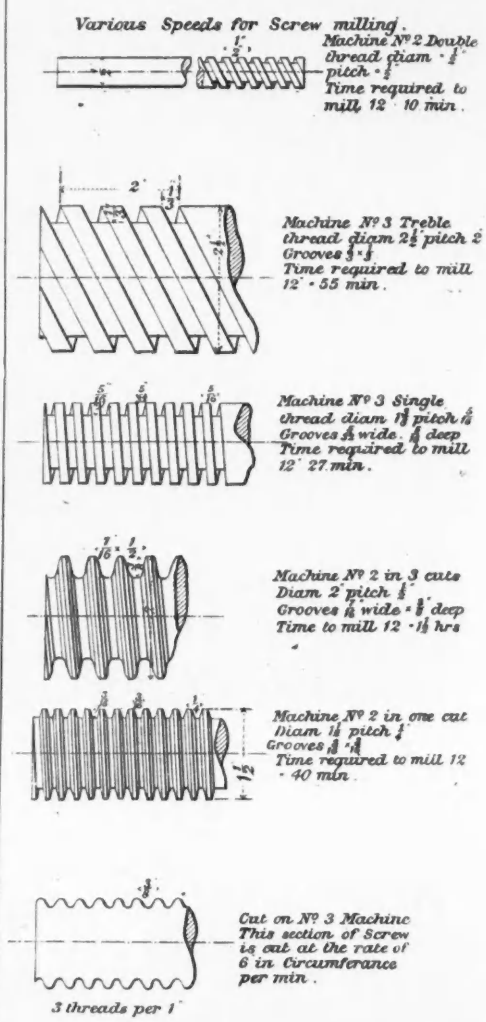


Fig. 13—SCREW MILLING MACHINE

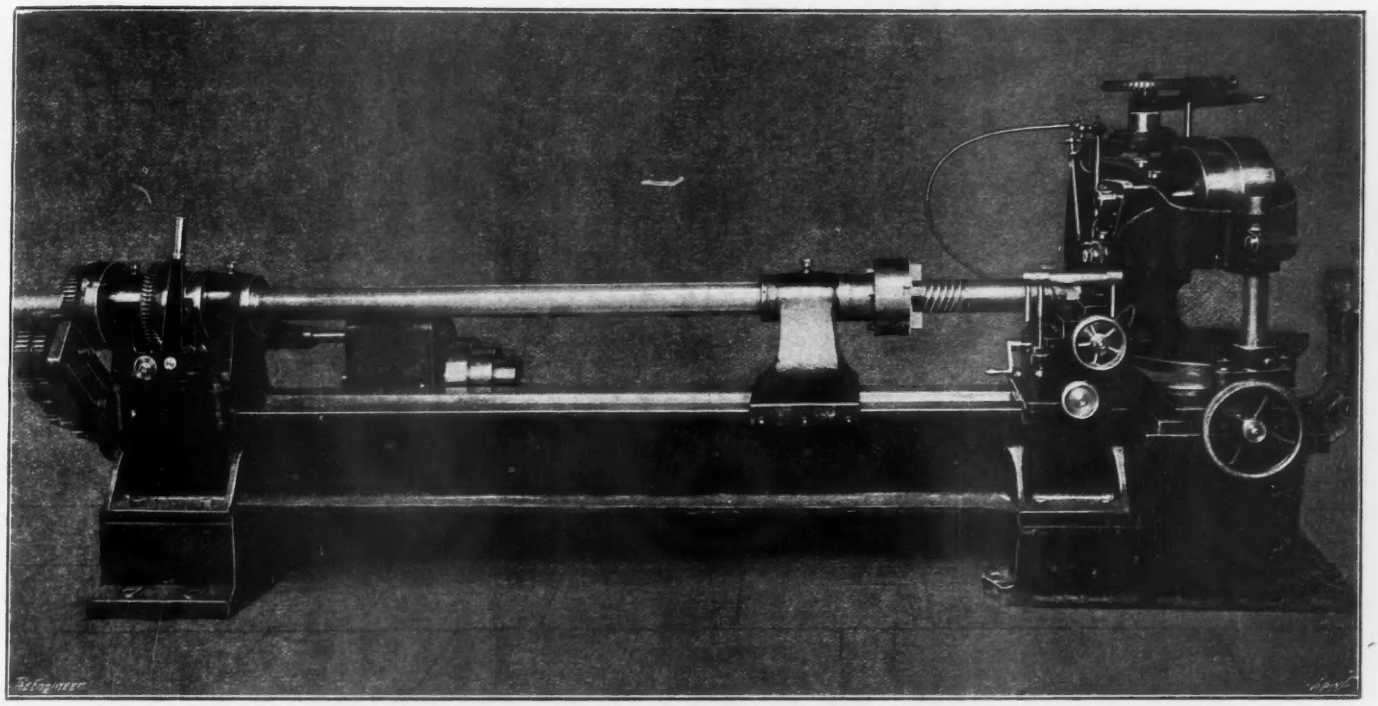
The larger machine is illustrated on the next page. This type consists of a long bed having a universal cutter headstock at one end, and what is virtually a hollow spindle lathe headstock at the other. Through the latter passes a hollow bar, supported on a sliding rest at its forward end, and provided with a four-jaw chuck. An external keyway is cut in it throughout its entire length, by which it is driven. The hollow spindle, as we have called it, is rotated by a worm and worm wheel, and drives a set of change gears, which cause the sliding rest to travel along the bed at the prescribed rate. The work is held by the four-jaw chuck and rests in a V groove, in which it is firmly held by a steel bar depressed by an excentric gear. This holds it down sufficiently firmly to prevent shake or vibration, but permits it to rotate and advance. The milling cutter is seen in the illustration, raised some distance above the work, and has unfortunately somewhat the appearance as if it were attacking the excentric clamp. It is mounted on a hardened steel spindle running in hardened steel adjustable conical bearings, and is driven by spur gear from a two-speed cone of 12in. and 9in. diameter for a 3½in. belt. The headstock is vertically adjustable on an angle bracket, which in its turn swivels round a centre, and is adjustable in a direction at right angles to the bed. By this means the cutter can be set at any angle up to 28 deg. with the axis of the work being cut, and at the same time it can be fed down so that the cutter may engage with the work. The thread is cut to the full depth at one operation. When square threads or a large angle are to be cut it is found necessary to use an ordinary tool to clean the corners up. A slide rest is fitted under the milling cutter for this purpose, and the tool mounted in it operates immediately after the mill, the work, of course, being fed past it, instead of along the work as in an ordinary screw-cutting lathe.

This machine is suitable for milling any shaped thread, right or left hand, and single or multiple, between the limits of 1in. and 2½in. diameter, and also the threads of worms and screws not exceeding 5in. diameter by 4ft. long. The pitch may be varied from ½in. to 2in. The chuck shaft, as we may call it, is, as we have already mentioned, tubular. It has a hole $2\frac{9}{16}$in. diameter, and bars up to 2½in. diameter enter it. It is thus possible to screw up to unlimited lengths by machining the four feet provided by the travel of the sliding head, then clamping the work down securely, loosening the clutch, running the head back and taking a new grip. For square thread a special patent stamped steel milling tool is used. It consists of a thinnish steel disc, which is locally pressed out sideways alternately to right and left near the edge, and then ground to the true section. The set on a circular saw will give roughly the idea. These cutters are, more cheaply produced than cutters of the ordinary kind, and they appear to be stiff enough to give quite satisfactory results. Cutters of this type are suitable, it is scarcely necessary to observe, for other work than milling screws. They are made in size between 2¾in. diameter and 6in. and from $\frac{3}{32}$in. to ⅜in. wide. The No. 2 screw milling machine is practically the same as this large machine, only modified to suit its dimensions. It takes bars of a maximum finished diameter of 1¼in. and a minimum of ⅝in., or worms not exceeding 2½in. diameter by 26in. long. Pitches from two to ten threads per inch may be cut on it. We illustrate also, Fig. 13, the smallest machine made on this principle. It will be readily understood without explanation. It consists of a vertical milling machine with a special rest mounted on the table. It is claimed that these milled screws are made more rapidly and with greater accuracy than lathe-turned screws. There seem to be good grounds for the former contention at any rate; but we have not had an opportunity of testing carefully the accuracy of the threads cut. For the purposes of their own lead screws the company rough them down in the screw miller and finish them on a lathe. This sounds a practicable plan, and we see no reason to doubt that accurate screws could be cut rapidly by this method. One of the uses to which this machine has been largely put is the production of armour-plate screws, a direction in which it appears to have been remarkably successful. The makers have kindly supplied us with the above table, giving the times required to mill a length of 12in., which will be found interesting.


Various Speeds for Screw milling.
Machine N° 2 Double thread diam · ½ pitch · ½ Time required to mill 12 · 10 min.
Machine N° 3 Treble thread diam 2½ pitch 2 Grooves ⅜ · ⅜ Time required to mill 12 · 55 min.
Machine N° 3 Single thread diam 1⅞ pitch ⅝ Grooves ⅜ wide · ⅜ deep Time required to mill 12 · 27 min.
Machine N° 2 in 3 cuts Diam. 2 pitch ½ Grooves ⅛ wide · ⅛ deep Time to mill 12 · 1½ hrs
Machine N° 2 in one cut Diam 1½ pitch ½ Grooves ⅛ · ⅛ Time required to mill 12 · 40 min
Cut on N° 3 Machine This section of Screw is cut at the rate of 6 in Circumferance per min.
3 threads per 1

LIEBERT'S SCREW MILLING MACHINE

JOHN HOLROYD AND CO., LIMITED, MILNROW, ENGINEERS



A small two spindle sensitive drilling machine is also shown on this stand. The spindles—each ¾in. diameter—are 10½in. apart, the right-hand spindle being 3in. in advance of the other, the distance from the face of the pillar to the nearer spindle being 5in. The maximum distance from nose to table is 10½in. and the feed by rack 2in. The spindles are driven independently direct by belt from a three-speed cone at the back of the standard. An automatic feed at the rate of 200, 332, and 550 revolutions per inch travel can be given. The drill is fitted with automatic stops and quick return by springs.

HULSE AND CO.

No attempt is made by Hulse and Co. to make a representative exhibit of the class of work with which their name is so closely and honourably associated. They are content to show merely some of the smaller tools they make. Indeed, it would have been difficult, if not impossible, for them to exhibit any of their largest machines. Those that they do show are worth attention. We might mention particularly the vertical milling machine illustrated in Fig. 15. This machine has been made now for many years, and on account of its stiffness and rigidity, has always found favour. Its feature is the hollow square slide, movable vertically through guides in the body of the machine, and containing the main spindle, which is thus rigidly supported against the side pressure on the tool. The slide can be locked at any desired level, or driven downwards when a vertical feed is required, as when the machine is used for drilling. A weight suspended in the column counterbalances this slide. The feed mechanism, both for the spindle and for the table, is shown clearly in the engraving. A small pump is fitted for supplying lubricant to the cutting edge.

Two planing machines, one of the ordinary type, to plane 6ft. long by 2ft. 6in. wide, with one tool-box, and the other, a side planer to plane 30in. long by 12in. wide, are also shown. These latter machines have come into favour of late after having been regarded with some suspicion for many years. We are informed by the makers that Mr. W. W. Hulse took out the patent for this machine as long ago as 1865. Hulse and Co. show also a vertical drilling machine with a table mounted on a long sleeve, so that it can be rotated round the column and fixed in any position relative to it; a useful combined milling cutter and twist drill grinding machine, and a couple of lathes. One of these is described as an improved double-geared screw-cutting lathe with independent action for sliding and surfacing. The lead screw is placed inside the bed under one of the shears, where it is well protected, and is more nearly in the line of cutting resistance. This advantage appears to be counterbalanced to a certain extent by the inaccessibility of the screw; but it must be admitted that except for cleaning it should rarely demand attention. The spindle is of hardened steel accurately ground into hardened steel conical bearings. This is rather an unusual practice in a lathe of this size, 7in. centres, at the present day, the parallel bronze bearing having almost entirely replaced the conical design. The other lathe shown by Hulse and Co., Limited, we illustrate Fig. 14. It is a simple form of open-spindle turret lathe, with screwing device mounted on the saddle. The lathe will take stock for turning 1in. bolts, and will admit between centres a length of 1ft. 6in. The saddle can be moved by a rack or a screw, the latter in the bed, and simple form of stops for sliding and traversing are fitted.

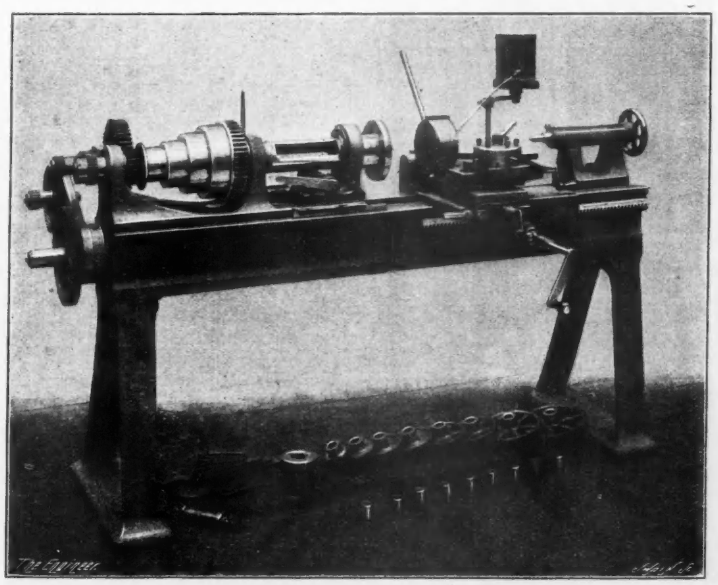


Fig. 14—OPEN SPINDLE TURRET LATHE BY HULSE AND CO.

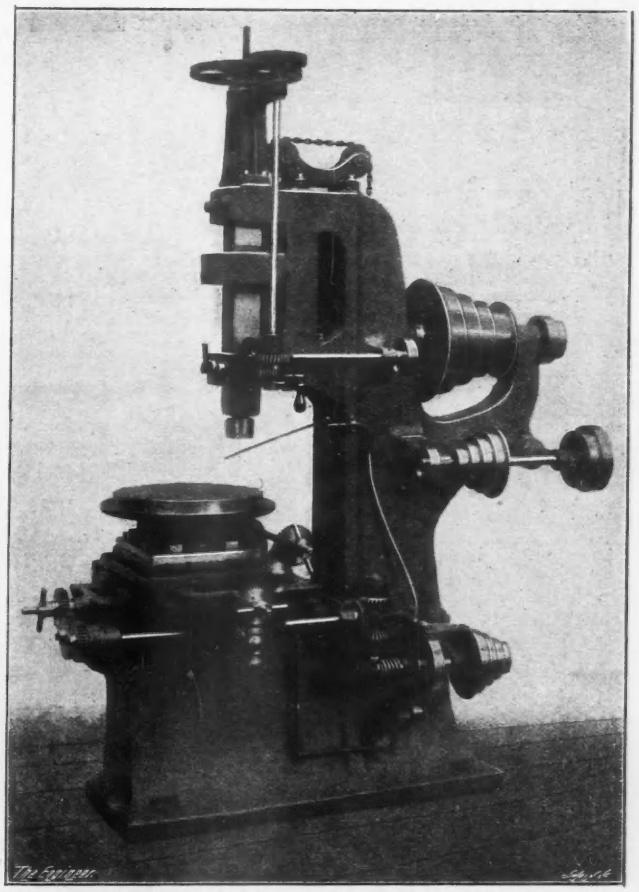


Fig. 15—VERTICAL MILLING MACHINE BY HULSE AND CO.

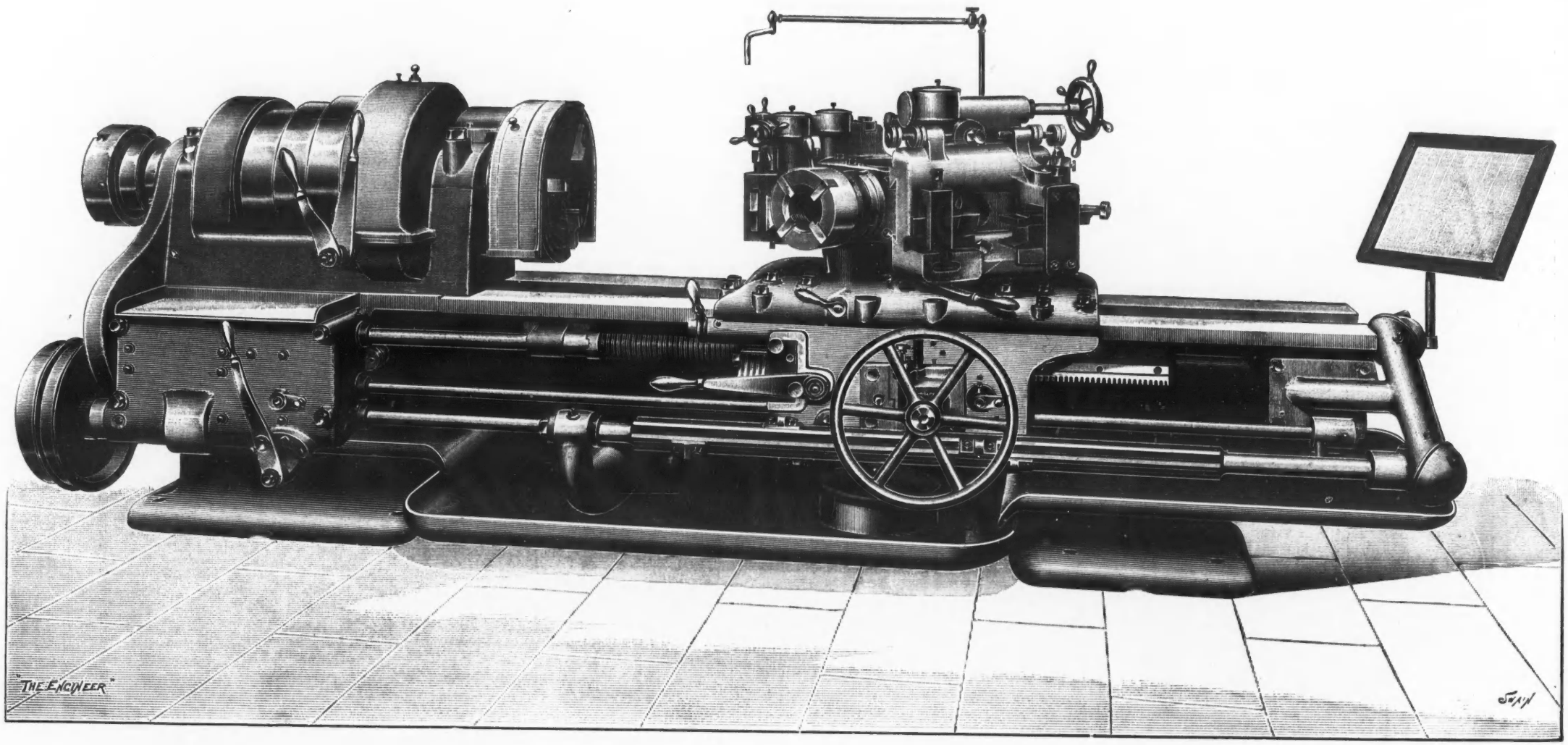
P. AND W MACLELLAN, LIMITED.

Besides several of Mr. Samuelson's clever little power hammers, a description of which, if it were needed, is scarcely within the scope of the present supplement, P. and W. MacLellan, Limited, show a special lathe for turning buffers. This takes roughly the form of a heavy hollow spindle lathe. It consists of a massive box bed, on one end of which is mounted the headstock, which is free to swing horizontally about a large fixed trunnion. The spindle is driven by powerful bevel gearing; its front bearing is movable longitudinally, sliding on the swinging plate which supports it. This plate has a toothed quadrant driven by a pinion, so that the buffer fixed by its shell in the chuck is swung in an arc in front of the fixed tool, and is thus given a curved face. By adjusting

No. 4 HEXAGON TURRET LATHE

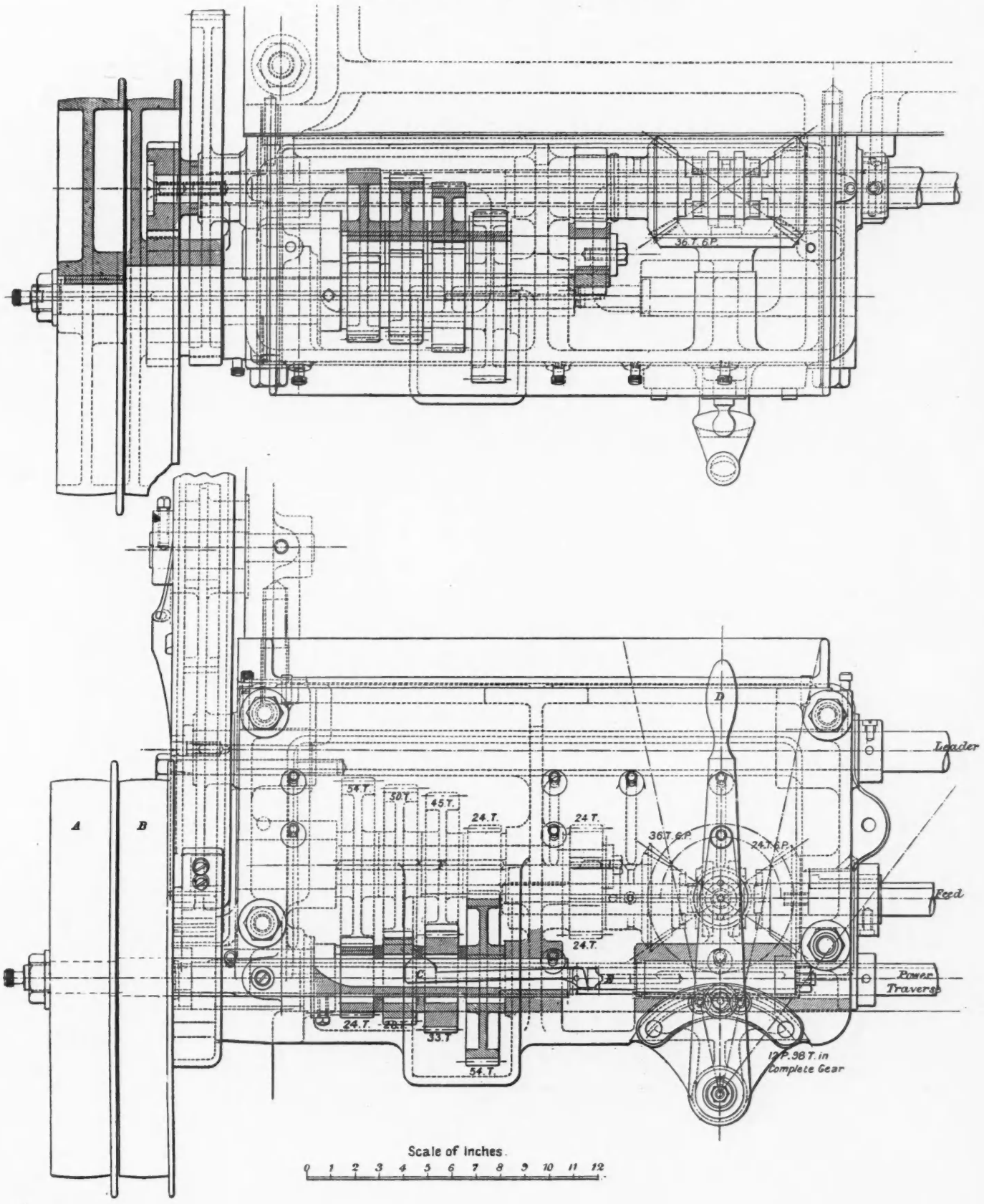
ALFRED HERBERT, LIMITED, COVENTRY, ENGINEERS

(*For description see page* ix.)



No. 4 HEXAGON TURRET LATHE—FEED BOX

ALFRED HERBERT, LIMITED, COVENTRY, ENGINEERS



"THE ENGINEER" SWAIN

the position of the work from the fixed centre, about which it swings, the radius may be varied from 36in. to 54in. The edge of the buffer is machined at the same time as its face by a tool mounted in a rest fixed permanently to the swinging plate. Straight-faced buffers can also be machined by locking the head and using the tool slide. In order to economise time an instantaneous change gear is fitted, so that after part of the buffer face has been machined the speed may be increased to complete the remainder. The spindle is bored out 8in. to suit the buffer shells, which are centred and chucked by two sets of screws. A cross handle at the end of the bed provides means for swinging the head to its limit to one side or the other, so that the work may be very readily chucked.

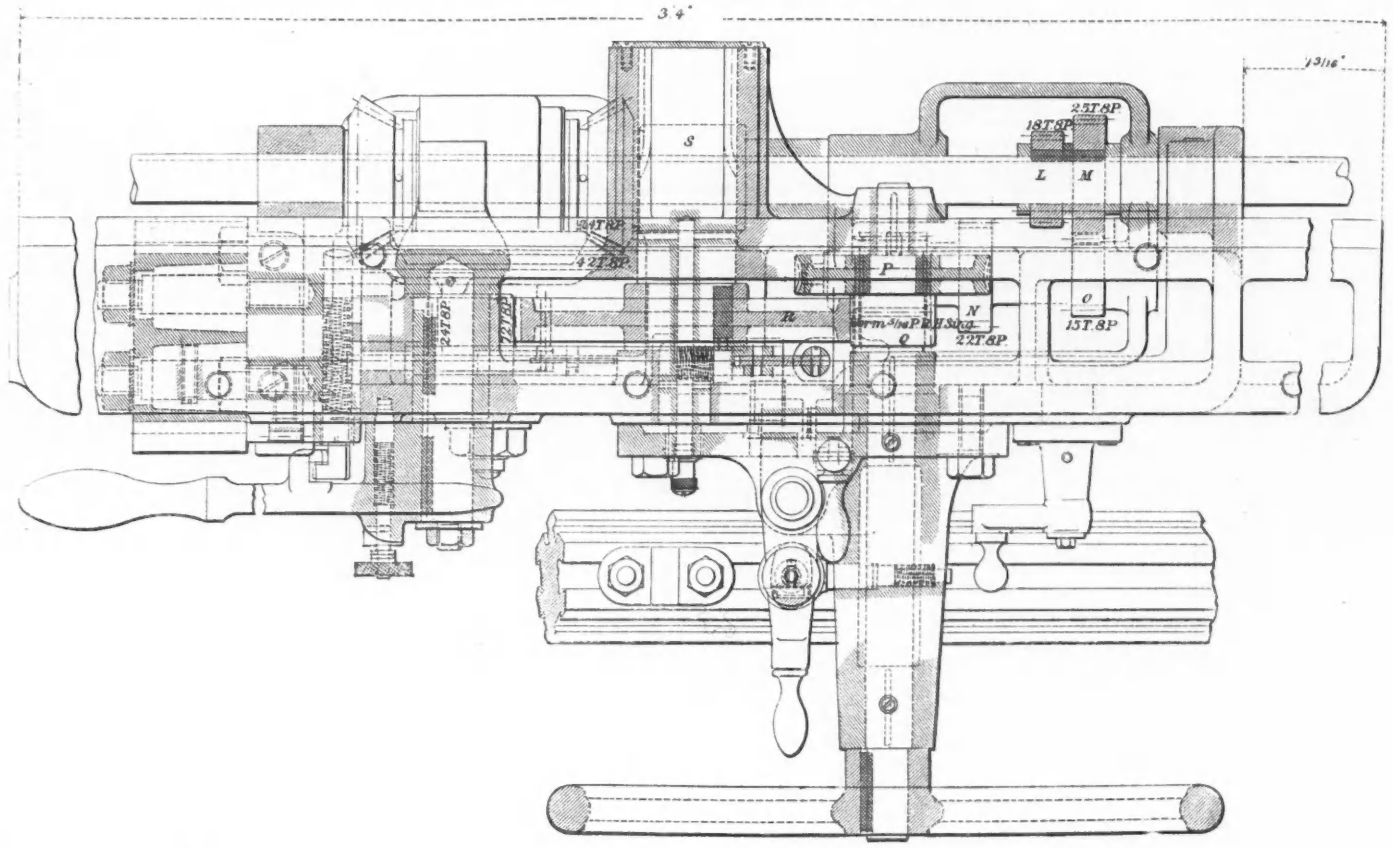
ALFRED HERBERT, LIMITED.

It would be impossible, as it is unnecessary, to describe in detail the numerous machines which figure on the stand of Alfred Herbert, Limited. Most of them are already very well known, for there is no company in this country which has devoted so much attention to the development of the modern machine tool as this Coventry firm, and there are very few works of importance where its machines are not known, and, we might add, respected. The company has done more than any other to produce full automatic machine tools in Great Britain. We have already on previous occasions, and notably in a supplement devoted to machine tools which appeared in November, 1899, described machines made by it, and as drawings have accompanied many of our articles our readers should be well acquainted not only with the appearance but the general details of its work. In the present instance we have again to thank the company for affording us the opportunity of giving very full particulars of a remarkable tool, a courtesy which our readers, with ourselves, will not be slow to appreciate.

We have taken for special illustration and description one of the most striking tools shown in operation at the Exhibition. It is the No. 4 hexagon turret lathe, of which a full description with drawings will be found below, and of which a general view is given on page viii. With regard to the drawings it is necessary to remark, as we have done on former occasions, that outlines and sections are mixed up in a way, at Herbert's, which is a little confusing. Our illustrations have been made from actual working drawings, and it has been impossible to avoid this peculiarity, but we have endeavoured as far as possible to give especial prominence to the more important features. The machine has been specially designed for dealing with turned and bored work from the bar. It will admit bars up to 3½in. diameter, and will also produce bolts, studs, &c., of larger size from forgings. The headstock has a cone pulley 21in. diameter for a 4in. belt, and is provided with two sets of double gearing thrown in by friction clutches—see page xi. The spindle has eighteen speeds. Six graduated speeds can be

No. 4 HEXAGON TURRET LATHE—SADDLE

ALFRED HERBERT, LIMITED COVENTRY, ENGINEERS



"The Engineer" Swain

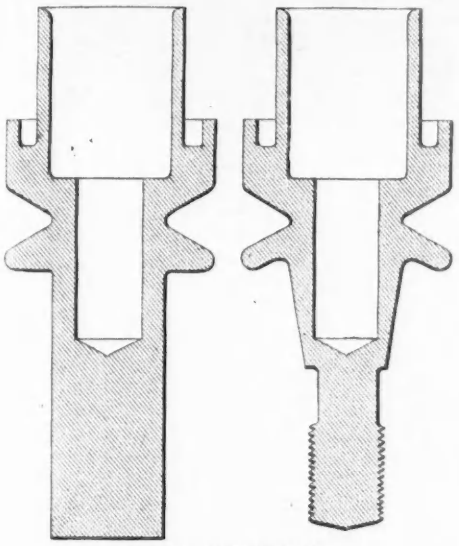
obtained at any time without shifting the belt upon the cone pulley. The spindle is bored 3¾in. diameter, and has a chuck on each end, the main chuck being bolted to a large flange forged solid with the spindle.

The feed gear provides four instantaneous changes of feed and reverse, and means for rapid traverse of the saddle are also provided. The feed-box is illustrated on page ix. The feed is derived from the pulley A, driven by belt from the spindle. A is mounted on a short shaft carrying four wheels with 24, 28, 33, and 54 teeth respectively—see drawing. These are all loose on the shaft; but a sliding feather C, actuated by the handle D, a quadrant keyed to it, and a sliding ram E puts any one of them in gear, or leaves them all out, as in the case shown in the drawing. These wheels drive a short countershaft, to which are keyed five wheels, of 54, 50, 45, 24, and 24 teeth. The last of these drives a sleeve and bevel pinion, the first member of a mitre reversing train mounted on the feed shaft. This is clearly shown in the drawing. Thus the four instantaneous changes of feed and reverse are given. The power traverse shaft is totally independent of the feed gear, and is driven by the pulley B, which is driven indirectly from the overhead gear. It is used for traversing the saddle quickly, or for high-speed drilling or boring. The leader spindle is also shown above. It is also quite independent of the feed gear, though it passes through the feed-box, and is driven by gear outside the head at a constant ratio. Different lead screws are slid on to it for different pitches. It is used always in conjunction with the screwing dies mounted in the turret, and seen in the engraving.

We come now to the saddle. The position of the two shafts is shown again in the drawing above. Taking first the power traverse shaft, it has keyed to it a pinion of twenty teeth, gearing with a twin pinion above it of thirty-two teeth. The latter is mounted on the feed shaft, which it can drive either direct or reverse by the friction clutch and bevel train shown. This clutch is actuated by the long horizontal lever K by means of quadrant and rack. It also serves the same purpose when the feed shaft is used direct. Thus the feed and the power traverse can both be reversed or stopped entirely by the movement of a lever on the saddle. It is scarcely necessary to observe that the feed and power traverse shafts must not be run at the same time. In both cases the rack which is seen in the engraving is used. We now proceed to consider the system of wheels which connects the feed shaft with this rack. On the feed shaft there are keyed two wheels L and M—see plan also—one with eighteen and the other with twenty-five teeth, which can be slid by the lever X to gear with either N or O, two wheels cut on a sleeve, part of which is formed into a worm gearing with the wheel P. This worm wheel P carries a pinion Q, driving a wheel R, to whose spindle is keyed the rack pinion S. It will be seen then that very ample control of the saddle is provided. To sum up:—We have first four changes and a reverse of the feed shaft in the feed box, with two changes and a reverse in the saddle; secondly, a power traverse shaft with two speeds and reverse on the saddle. These feeds are so proportioned as to be suitable for the fine cuts required for heavy reductions or for drilling from the solid, up to the quick traverses necessary for boring and rough-turning forgings. The feed motion, quick-power motion, and chasing arrangement are automatically interlocked, preventing the possibility of breakage through two motions being accidentally engaged at once. The chasing and screw-cutting arrangement is independent. It is used for the purpose of guiding the die, securing accuracy of pitch, and dispensing with great skill on the part of the attendant.

The hand traverse is effected by a large wheel in front of the apron. On its spindle the pinion and worm wheel P and Q are keyed. It can, of course, only be used when the power feed is out. It would be difficult with the space at our disposal to make the release gears clear,

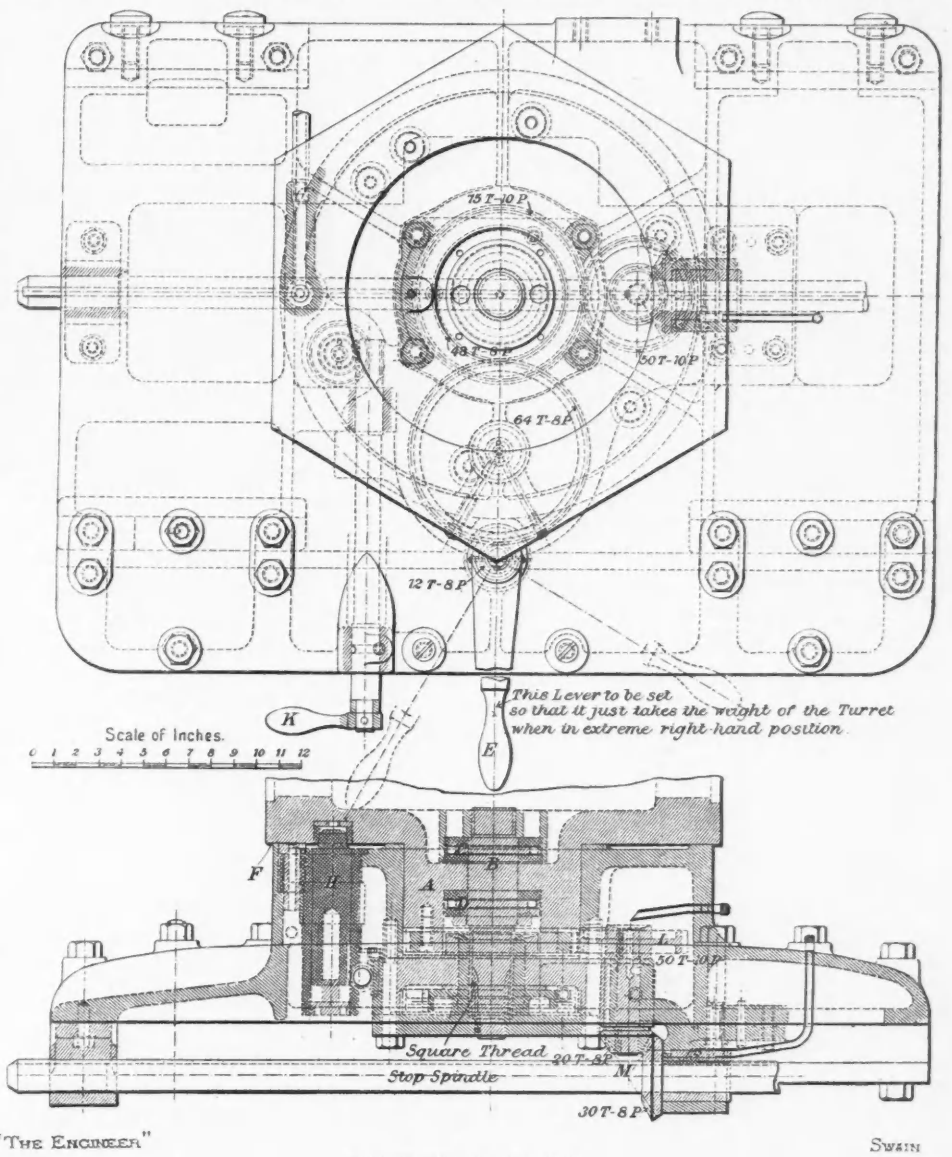
Those who have read our former description of a No. 6 Hexagon lathe, by the same makers, will know pretty well the lines on which it works. Suffice it to say here, that the worm which drives P, with the two wheels which form an integral part of it, are mounted in a box capable of oscillation upon the feed shaft. To put in the self-acting motion the box is raised, bringing the worm up into gear with the wheel P; to put it out the box and worm are dropped. This can be done by hand, or automatically by the stops, which now require attention. It only remains to remark with regard to the saddle, that the lead nut is a half nut mounted at the left-hand end of the apron, and moved sideways by a lever immediately over it. Several nuts are supplied, each of which is cut at each end to two different pitches to suit a range of leaders. In this machine the hexagon bar form of stops has been adopted in place of the notched bars. Automatic stops are employed for sliding only, all cross-cutting being effected by special tool-boxes, to be described later. The position of the stop bar is well shown by the engraving. From one point of view the position of this bar, so far from the centre line of the work, does not seem as good as the old form, where the pull was much nearer the line of resistance. However, we are informed by the makers that no trouble is experienced on this score, and that there are counter-balancing advantages in the matter of accessibility and ease of adjustment. It is operated in a very simple manner. A shaft terminating at the open



Figs. 16 and 17—WHIRLERS

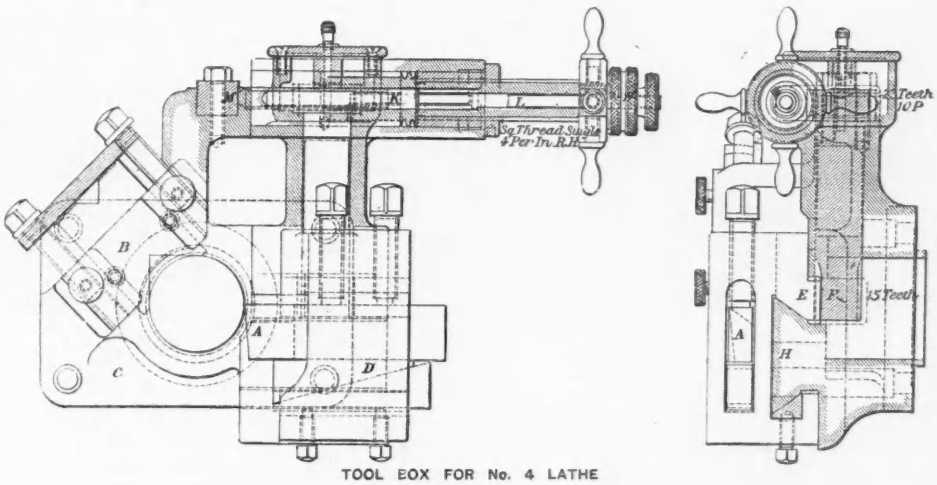
end of the lathe, in a bevel wheel, is rotated by a sliding bevel wheel, which is caused to revolve by the rotation of the turret. This motion is transmitted to the stop bar by a shaft and wheels contained in the casing at the end of the bed. The actuating mechanism is better shown in the drawing of the turret, to which we now turn.

Our general illustration gives, unfortunately, a poor idea of the solidity and apparent mass and ponderousness of this turret. It is, we believe, the largest thing that has been attempted in this form. From face to face of the turret itself is over 20in., and it is 16in. from the top of the shears to its summit. Upon it are mounted six tool-boxes, all more or less large things, which give a very heavy appearance to the whole. But as the makers, in getting out this fine lathe, have worked with the object of making it as easy to handle as a much lighter machine, special provision has been made for taking the weight of this turret. It can, as a matter of fact, be revolved without effort with one hand. It is shown with the saddle in the annexed drawing. It is provided with a large spigot A, 8in. diameter by 4in. deep, carefully fitted into a corresponding socket. Through the centre of it there rises a shaft B, provided with two ball races C and D, which enclose between them a ring fashioned on A. The shaft B is screwed for part of its length, and a spur wheel is keyed to it. A lever E, plan, by means of a pinion and idler, turns this wheel, thus raising the screw and lifting the turret from the face F. It is then entirely supported between the two ball bearings, and can

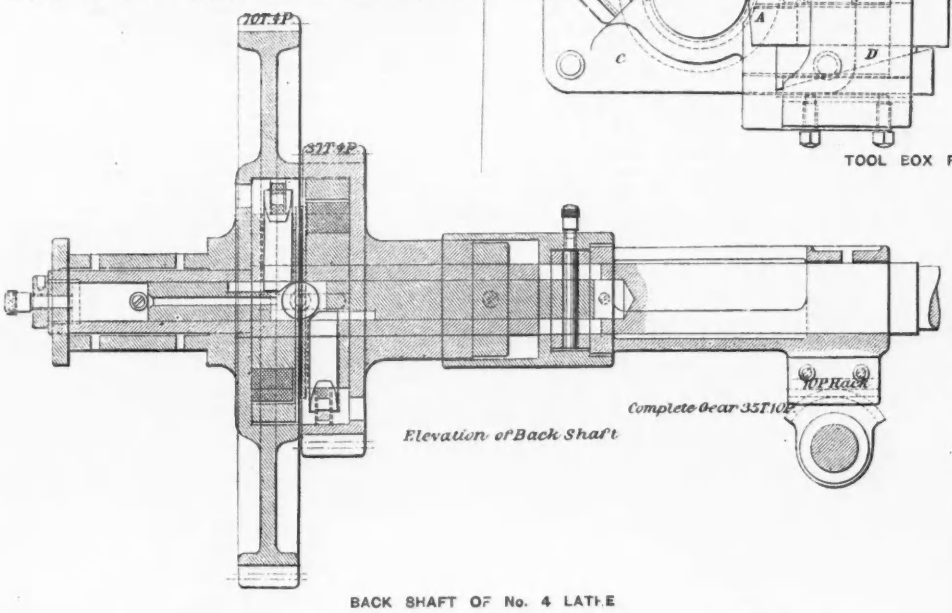


"THE ENGINEER" SWAIN

TURRET FOR No. 4 LATHE



TOOL BOX FOR No. 4 LATHE



BACK SHAFT OF No. 4 LATHE

be readily revolved. The same lever serves also to draw it firmly down on to its seat before starting a cut. The turret is revolved and located by hand. The locating pin is shown at H in the section, and the means of raising it by the little lever K, with pinion and rack, is made clear by the plan. The mechanism for turning the stop bar is also shown in the section, where L is a wheel gearing with one fast to the spigot A, driving the bevel pair M and the stop spindle.

It only remains now to describe the tool-boxes. We have taken for the purpose of illustration that used for turning tools. It is shown herewith. It is a large casting with a base plate C, by which it is bolted firmly to one of the faces of the turret. The tool A is fastened in a carrier D, which slides on a dovetail H. On the back of D a rack E is cut and meshes with a pinion F in a stout vertical spindle, to which is keyed at its upper end a spur wheel with twenty-three teeth. A horizontal shaft L, to which is keyed a small hand wheel, is screwed with a square thread for part of its length, and for the remainder is turned into a cylindrical rack K, which gears with the spur wheel on the vertical spindle. As this

shaft is screwed in through a long nut, the rack part of it rotates the vertical spindle, which in turn feeds forward the tool. The adjustment for cut is made by the knurled nut N, which moves a rod fixed centrally in the screw shaft, the end of which butts against the fixed block M. A back steady is shown at B. It consists of two similar pieces of steel, whose position is fixed by a yoke commanded by two screws. The cutting off tool-box is shown

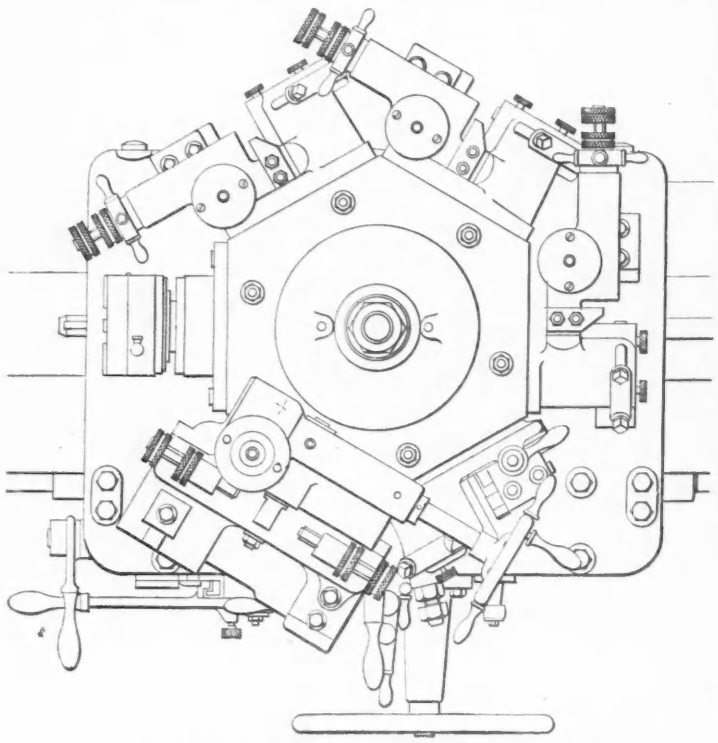


Fig. 18—PLAN OF No. 4 TURRET WITH TOOL BOXES

well in the engraving, page viii.; it differs somewhat from that just described in that it carries two tools, and that a stop for both directions is provided. For screwing purposes a self-opening die head, with four chasers, suitable for work up to 2½in. Whitworth is fitted. A pump mounted at the back of the lathe supplies lubricant. We give also Fig. 18, a plan view of the turret and saddle, which show the arrangement of the tool-boxes.

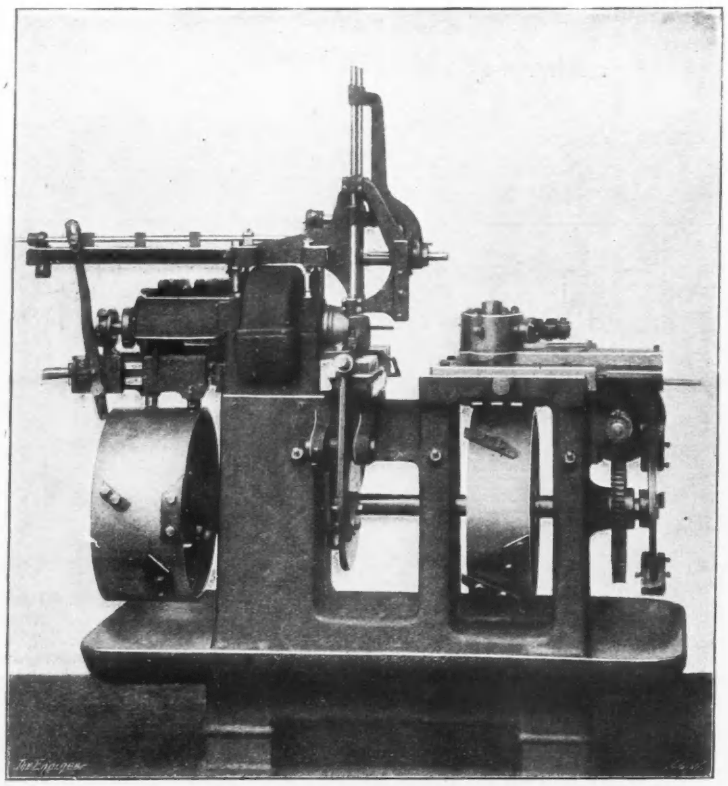
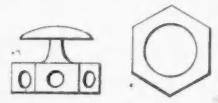


Fig. 19—AUTOMATIC LATHE, WITH MAGAZINE

A number of full automatic machines are shown, but those which present features of most interest are two fitted with magazine attachment as shown in Fig. 19. One of these is completing engine studs, upon which the first operations are performed on a No. 2 automatic screw machine working from the bar. The other magazine lathe is completing whirlers for cotton mill machinery. These are made on two machines. The first machine works from the bar, and produces pieces of the size and form shown in Fig. 16, page xi. At the Exhibition the time required for this work was, on the occasion of our visit, eight minutes. The pieces thus formed are then put into a trough above the headstock of the second machine, and are then taken charge of by the machine and reduced to the finished form shown in Fig. 17. The magazine attachment is a detail to be regarded as quite separate from the lathe. It can be fitted or withdrawn at will without in any way affecting the value of the lathe for other work. It consists of a V-shaped trough, which extends in the line of the lathe over the headstock; a device for feeding the articles to be machined along this trough; a cradle for receiving them one at a time, and for carrying them down into position in front of the chuck, and there at the proper moment releasing them. In the particular case of these whirlers a little cradle is placed under each in such a manner as to keep it horizontal as it lies in the trough. A bar with loose lugs, which engage the pieces when moved in one direction, but ride over them when moved in the opposite direction, is given a to-and-fro motion by a lever seen in the engraving, and actuated by a hump on the edge of the cam drum at one point in its periphery. This action pushes one piece at a time into a half-tube or cradle mounted in a sliding piece, which is caused to descend at the desired moment by a cam. In its descent a spring is set which gives the half-tube a tendency to rotate, but which is withstood by a catch. A free plunger projects from the forward end of the half-tube, its inner end resting against the piece of work. At the moment the cradle is lowered opposite the chuck the latter opens, dropping the previous piece, the turret then approaches, and, pressing on the plunger, pushes the piece of work into the chuck, which immediately closes at the same instant, releasing the catch and allowing the cradle to turn over. The slide is then free to rise against, and the turret begins work on the exposed part of the piece. The whole operation of automatically chucking and machining the item illustrated in Fig. 17 takes but little over six minutes at the Exhibition.

The No. 2 automatic screw machine, referred to above as doing the first operation on studs, is a perfectly new design specially adapted for making engine studs. Instead of a revolving turret, it is provided with a cross slide, which carries a box tool and a die head. First, the former acts, reducing the bar to size, then the carriage retires and the cross slide moves rapidly across, bringing the dies in position. It is claimed that no machine in existence can turn out studs more quickly than this. The magazine is fitted to it for screwing the opposite ends when a sufficient number have been cut off. Of the other automatic machines shown we might mention a small screw machine, which is making buttons of the form and size



illustrated from brass hexagon bar at the rate of thirty-five seconds each. This involves a very novel equipment of tools, as the buttons have to be turned and formed, the sides of the hexagon milled and holes drilled, and the maker's name rolled on the front without stopping the spindle. These little buttons are being given away as souvenirs. Besides these smaller tools and the No. 4 hexagon lathe, described above, a No. 6 hexagon lathe, into which we went very fully in a special supplement two years ago, is shown; and several milling machines also figure on this stand. The composition of the stand has been carefully worked out, and is in itself an object-lesson in the proper arrangement of machine tools

JOHN HETHERINGTON AND SONS.

A good display in a limited space is made by John Hetherington and Sons, Limited. For the greater part, however, the machines they show are of established designs, and differ only from previous tools in minor points. One entirely new machine shown by them is illustrated by Fig. 22. It is a powerful milling and drilling machine, to which an attachment for profile work can be added when desired. It is made in three sizes, the No. 2 size being shown. It has a steel spindle 4in. diameter, the lower end of which is supported by a long steel slide having a vertical adjustment of 12in. The spindle revolves in long double-coned gun-metal bushes, with lock nuts and friction washers for taking up wear.

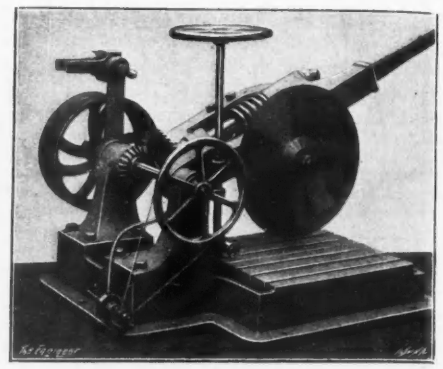


Fig. 20—LEVER FEED SAW

The vertical slide can be adjusted by hand, or when the machine is used for drilling, fed down by power in a manner which is quite obvious from the engraving. The smaller machine has not this fitting. An adjustable cutter stay is also provided. The drive is taken from a four-step cone through a disengaging clutch and single or treble gear in the manner shown. Both tables are provided with ⊥ slots, and the circular table is removable. There are full self-acting motions in all directions, all independent of each other, and to each slide a carefully graduated steel scale is fitted. The lever shown in front of the machine in a convenient position reverses all the feeds. It should be noted that the various handles and levers for manipulating the machine are placed on the same side. A pump for supplying lubricant is fitted and all the gear wheels are

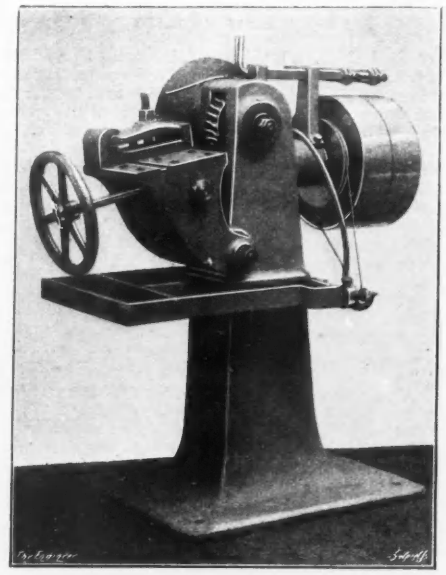


Fig. 21—SMALL POWER SAW

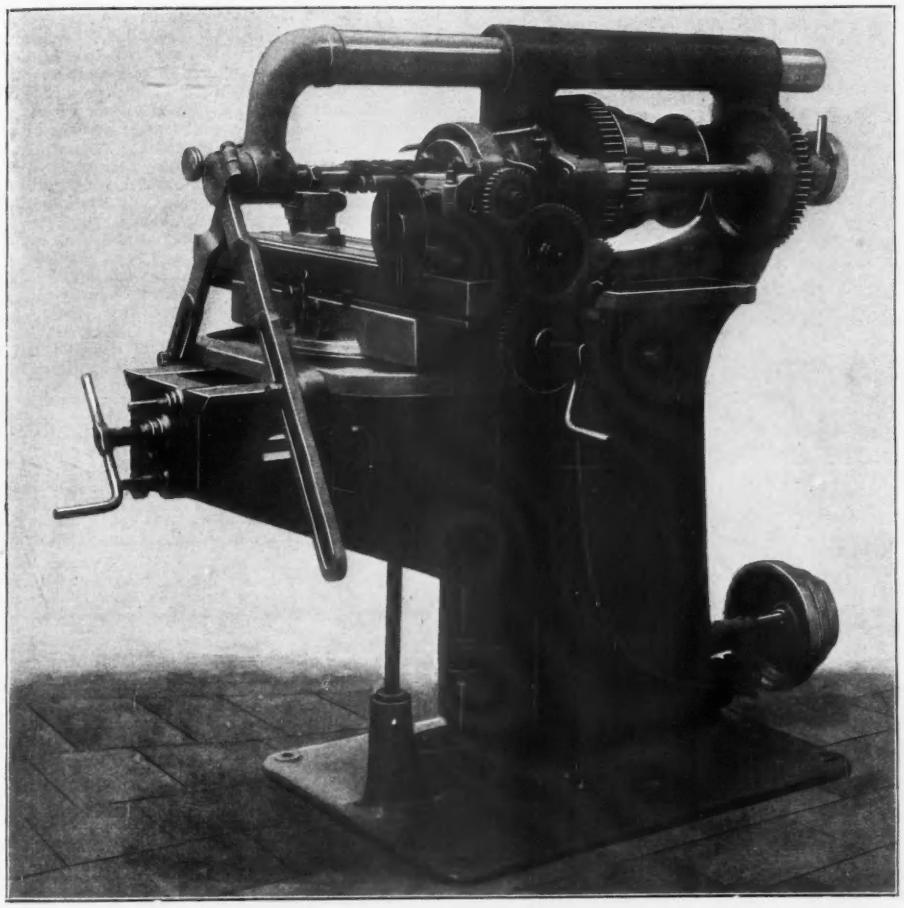
machine cut. The profiling arrangements consist of a cut steel rack coupled to the longitudinal slide, a weight and an arm, and hard steel roller hinged to the upright, so that it may be swung out of the way when not required. All screws and shafts are of steel, and all working nuts of gun-metal. The following particulars as to dimensions amplify the above description :—

Number of machine	2
Diameter of steel spindle	4in.
Traverse of spindle slide	12in.
,, table longitudinally	2·6ft.
,, ,, transversely	3ft.
Profiling arrangement, maximum movement of	0·5in.
Size of square table	2·3ft.
Diameter of circular face table	2·6ft.
Distance from square table face to under jib ...	2·3ft.
,, ,, circular table to under jib... ...	1·6ft.
,, ,, spindle to upright	2·3ft.
Speed arranged for cutters, diameter from ...	3in. to 9in.
Diameter and length of spiral cutter	4in. × 8½in.
Diameter of pulleys and speed of countershaft, inches	14 × 5¼ : 300 28 × 5¼ : 240
Floor space, feet	10·6 × 7·6

A substantial universal milling machine which is shown by this firm we also illustrate, page xiii. The point in it to which particular attention may be directed is the substance and width of the several slides. It cannot be repeated too frequently that the desideratum in a milling machine above all others is stiffness. It is not nearly

UNIVERSAL MILLING MACHINE

JOHN HETHERINGTON AND SONS, MANCHESTER, ENGINEERS



enough in a milling machine to provide ample strength. A great deal more than enough strength must be provided. Absolute rigidity it is impossible to obtain, but generous proportions and weight—regarded as weight not as strength—have a steadying effect which reduces the tendency to vibrate, and thus saves both the machine and the tools and produces better work. Width of seatings is particularly desirable, so that overhang may be reduced to a minimum. This is a point which appears to be neglected in some milling machines, and it is no uncommon thing to find the top table three or more times as wide as the slide in which it works, the bracket at the same time being correspondingly narrow. In the machine before us this point has been carefully considered, as the engraving shows fairly well, but a few dimensions will make more evident. The width over the vees on the bracket is 14in. The swivel slide bears on a diameter of 18in., and is deep, so that the overhung parts may be stiff. Its maximum length in the slides is 30in., and the length of the working lower face of the table is 38in. The total travel of this table is 24in., so that it has at either limit a matter of 22in. well supported, which should be sufficient to resist any tendency to bend. This machine is arranged for twenty-four changes of speed, and has eight feeds for each speed, with instantaneous reverse and stop motions. Micrometer scales are fitted on the slides for adjustment to $\frac{1}{1000}$ of an inch, and it has the usual self-acting motions. A small point, but one worth noting, is the cupboard. Instead of fixing the shelves in the pedestal, as is the usual practice, they are fastened to the door, so that when it is open the shelves, and whatever they contain, are readily accessible. It is unnecessary to say that the machine conforms in its working parts to the highest standards of present-day demands.

Among the few metal saws shown in the Exhibition, two are given prominence on this stand. Both of these we illustrate. The first, shown in Fig. 21, page xii., is intended for the usual small work of an engineer's shop, for cutting bar, bolts, angles, tees, &c. The saw is only 10in. diameter, and the maximum bar that can be cut is 1½in. by 1½in. The manner of clamping the work and operating the tool will be readily understood from the engraving. A hard steel spindle running in gun-metal bearings is used. The worm wheel is of gun-metal, the worm of steel, and works in an oil bath. An adjustable stop for cutting off lengths is fitted, and a small pump supplies lubricant to the blade. The other saw is of quite a different pattern, but will be equally readily understood from Fig. 20. The saw blade is 22in. diameter, and it will cut bars up to 5in. by 5in. or channels and girders up to 12in. by 6in. The worm wheel is of gun-metal, the worm of steel, and a swinging oil trough provides for their ample lubrication. The feed is put on either by a hand wheel and screw or by weighting the lever

MATHER AND PLATT.

Among a variety of other things which we have already briefly described, Mather and Platt show a magnetic portable drilling machine which has some just pretensions to novelty. Not only is the spindle driven electrically, but the same current excites a magnet by which the drill is attached to the piece on which it is to operate, or more generally to any flat prepared iron surface. The principle of attaching a machine magnetically is, of course, far from new, but we are not aware that a whole radial drilling machine has been constructed for that application before. This is a fairly large tool, consisting of a vertical cylindrical column 7ft. high by 12in. diameter, crossing which at right angles is fitted in a bracket which can be raised or lowered by a screw, a cylindrical arm carrying at one end an electro-motor, and provided with a drilling saddle which slides along the other and longer limb. The maximum radius of action is 42in. The saddle being circular permits of the spindle being moved in a vertical plane all round the radial arm. The radial arm can also be swung round its bracket in a vertical plane, so that with the full combination of movements the spindle can be inclined at any angle in any plane. All the adjusting clamps can be safely loosened together without fear of any part overbalancing. The spindle is direct-driven from the motor shaft, and the gear is proportioned to allow of a maximum diameter of 2¾in. being drilled from the solid. In the case of heavy cuts it is considered advisable to use dogs in connection with the magnetic attachment to prevent creeping. The holding-down magnet exerts a maximum resistance of three tons.

The holding-down magnet is enclosed in an enlarged base or foot, and current for it is taken from the same source as that driving the motor, the circuits being so connected that the act of starting the motor magnetises the holding-down coil and thus prevents accidents. The driving motor is of the two-pole enclosed type, capable of developing 2 horse-power at 800 revolutions; it drives the spindle through spiral gear with a ratio of nine to one. Back gear of three to one is also fitted, so that the spindle can be run at 90 or 30 revolutions per minute from the motor at full speed. For slower speeds the revolutions of the motor are diminished. Power and hand feed are provided, and a loop for raising is fixed to the column. The net weight of this useful machine is 30 cwt.

CARRON COMPANY.

The turning of screws with threads not a multiple of the threads of the leader is always attended with difficulty. To get over this the Carron Company have recently perfected devices which are shown fitted to two lathes at the Exhibition, and of which illustrations are given on the next page. The essential feature of this improvement consists in a special arrangement whereby the rotation of the screw is stopped before the locking nut can be opened, and the reverse motion closes the nut before the screw can be put in operation. The drawing of the apron, Fig. 23, shows part of the mechanism. Here A is a lever keyed to

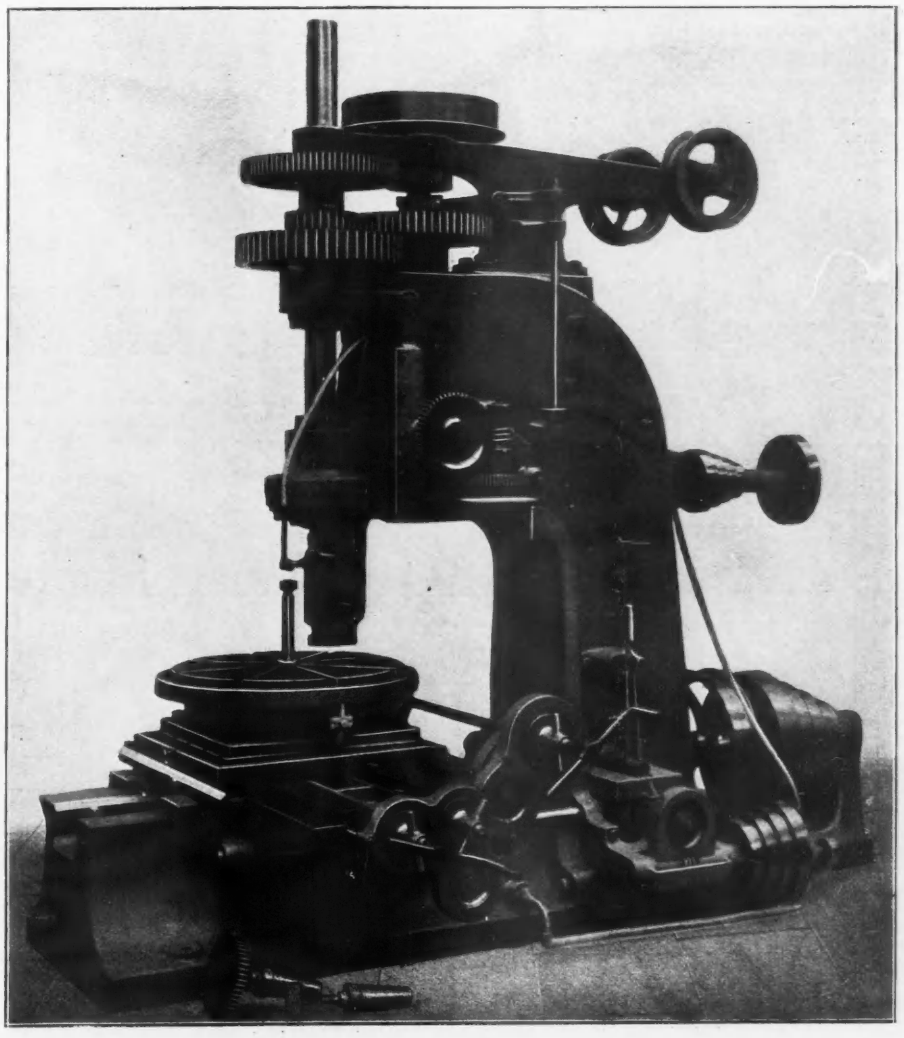
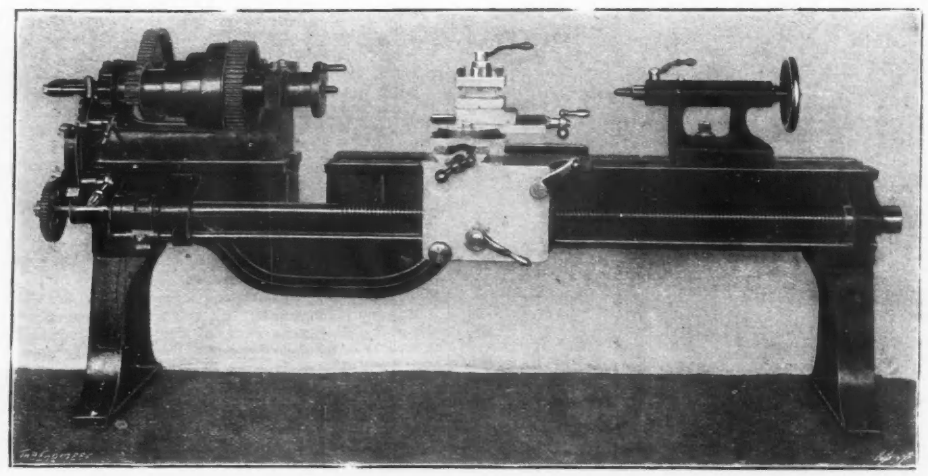
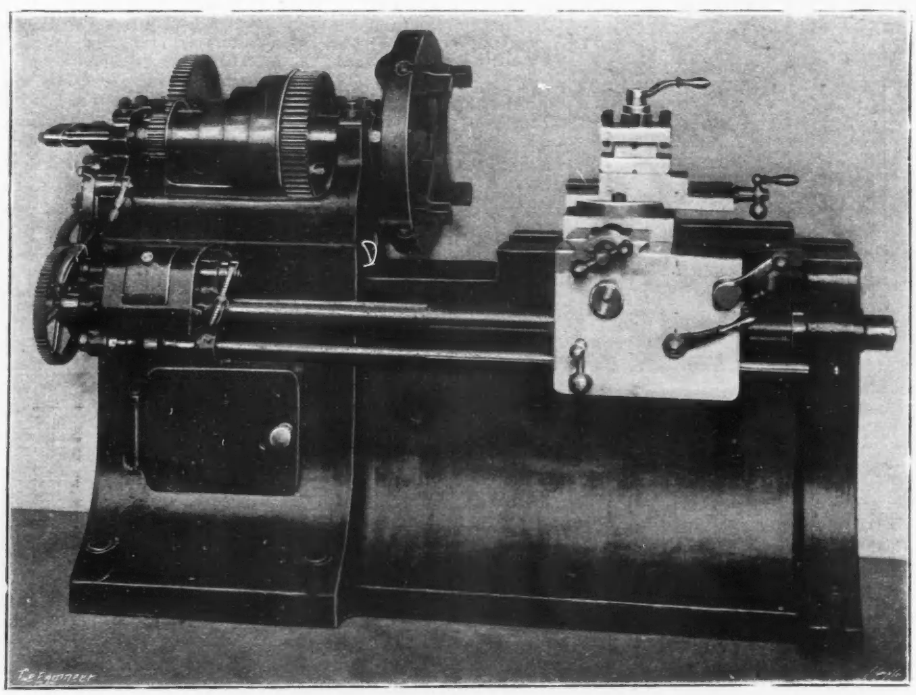


FIG. 22—VERTICAL MILLING AND DRILLING MACHINE, BY JOHN HETHERINGTON AND SON

8½ IN. CENTRE LATHES

THE CARRON COMPANY, CARRON, ENGINEERS





a disc, part of which is provided with teeth working the nut cam B. It has also a single tooth which at a certain position engages a striking plate C. The latter rotates a air of bevel wheels, of which the second is on a shaft extending along the front of the lathe. The striking plate C can be put instantly in or out of gear by the knob E, as shown in a detail. The handle M is for sliding the saddle along the bed. The shaft already mentioned and marked K in the end view, enters a box by the headstock, enclosing the mechanism shown in Fig. 25. It has on it a spiral pinion engaging a rack which slides one member of a clutch on the lead screw. By rotating the shaft K, this clutch is thrown in or out. The clutch is irregular, as shown in detail, so that it can engage only in one position. An alternating form of clutch is shown in Fig. 26, in this case it is of the multiple tooth form. But the sliding member has a separate piece A, which can be run in or out by rotating an excentric pin B with a screw-driver. Its projecting end prevents the two parts of the clutch engaging at any save one position, where a recess is cut to receive it. It is used in the face plate lathe illustrated herewith, whilst the first form is shown on the other lathe illustrated. They are both of 8½in. centres and self-acting throughout. In the former a range of feeds between 2 and 256 per inch is provided, and an instantaneous change of feed from two to one can be made. The quadrant or swing plate is pivoted from the head instead of the screw, so that the intermediate wheel remains constant, and only one wheel need be changed for different feeds or pitches. The tool rest is a revolving block capable of taking four tools. The rest for the other lathe is very similar. A detail worth observing is the provision of a table indicating the standard pitches, with their respective wheels on the swing plate. When it is desired to cut a screw, the index line belonging to the desired pitch in this table is brought opposite a fixed pointer and the swing plate locked. The intermediate wheel then gears properly. This is a simple and effective plan.

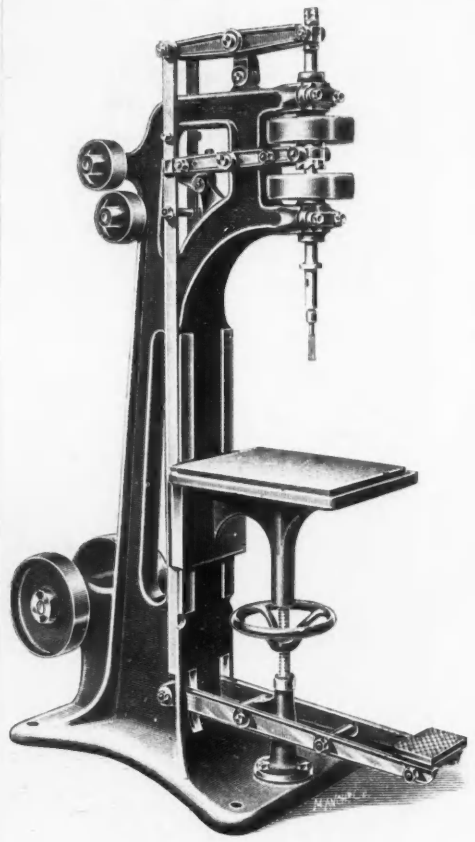


Fig. 24—CARRON DRILLING AND TAPPING MACHINE

An interesting little machine for drilling and tapping, shown by this firm, is illustrated by Fig. 24. The spindle sleeve is mounted between two bearings and carries two separate pulleys. It has a constant vertical travel of 4in.

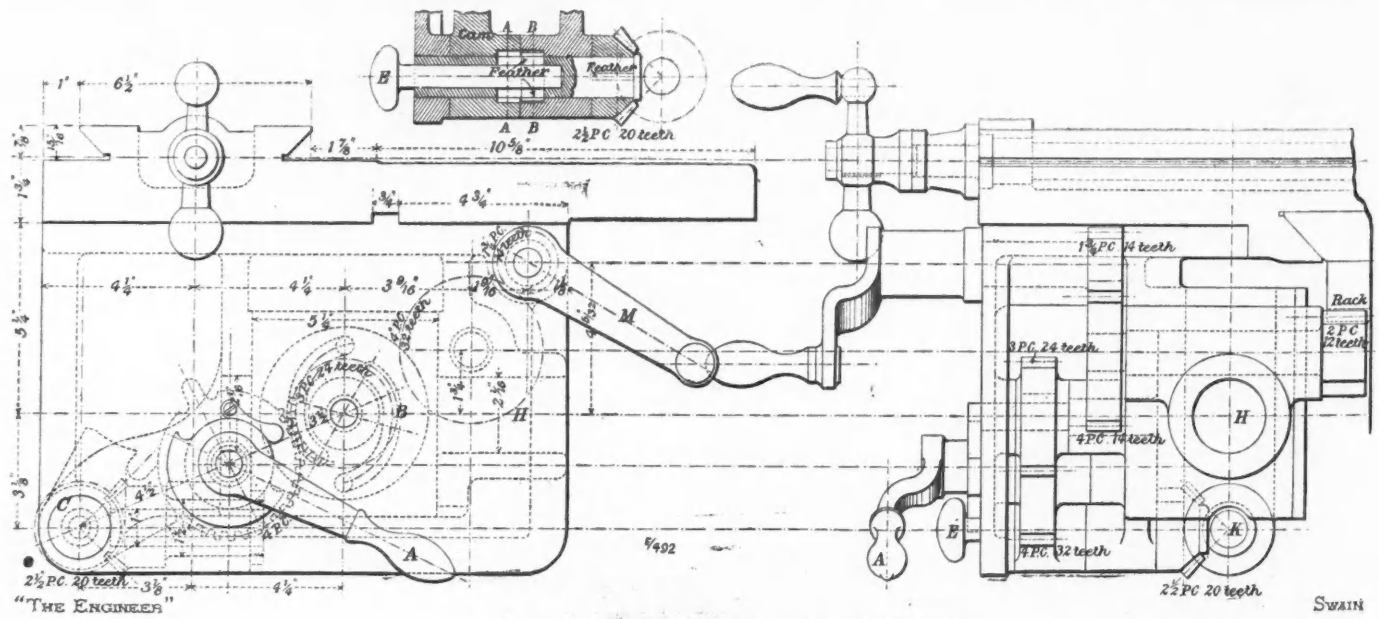
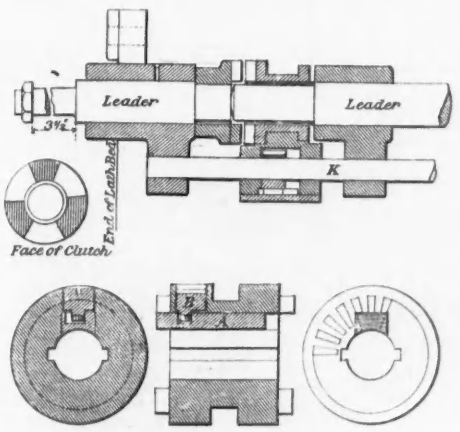


Fig. 23—SADDLE FOR 8½in LATHE BY THE CARRON COMPANY

thence over another guide pulley and down to a pulley on the base of the machine, up again round the other spindle pulley and back to the driver. Thus the two pulleys on the spindle revolve in opposite directions. Between them is a clutch which enables either to be thrown in. Tappets on the feed rod throw this clutch automatically when



Figs. 25 and 26

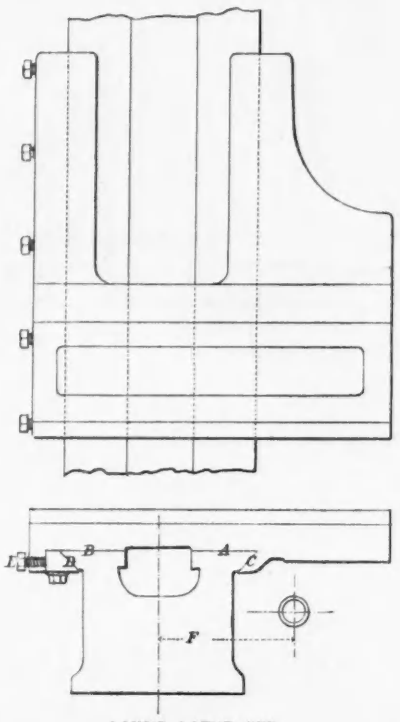
tapping, and reverse the spindle. The depth is adjusted by fixing the table further from or closer to the drill spindle. The machine is intended to drill and tap holes up to ¼in. diameter. It is a well-finished and handy little tool.

GEORGE RICHARDS AND CO., LIMITED.

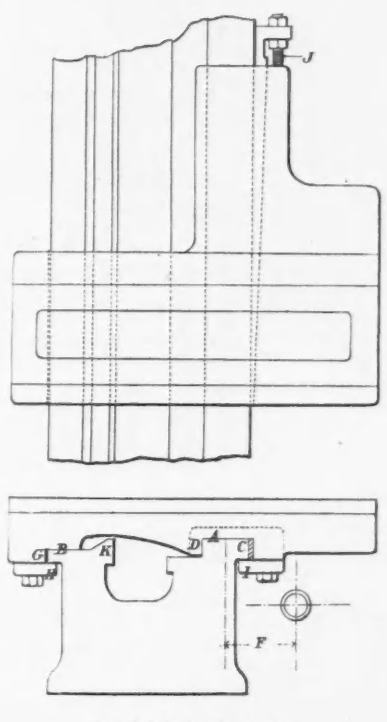
The smallness of the space allotted to George Richards and Co., Limited, has scarcely given them an opportunity of displaying their machine tools to advantage. We might ask, why their stand is separated from all the other machine tool exhibits and is placed, if we recollect rightly, close to a sweetmeat manufactory? The tools that they show are practically the same as those they exhibited at Paris, and have been so recently illustrated in these pages, that little need be said about them. They include a small side planer, a machine to the development of which the firm has devoted a good deal of attention; a slot drilling and cutting machine in which the spindle is driven direct by a belt; and a small boring mill, to the table of which we understand a live roller ring has been fitted with considerable success.

VICTOR COATES AND CO., LIMITED.

A machine tool which will be found interesting to boilermakers is a drilling machine designed by Victor Coates and Co. Limited, for drilling the flanges or Adamson joints of Cornish and Lancashire boilers. The rivet holes through the three thicknesses which form the joint have, of course, to be drilled together. The edges of the flanges are previously turned, and the flanges are clamped together with the ring between them. In this position the flue is dropped through a central ring in the machine, and the edges of the flanges are seized by adjustable jaws. The whole ring with the two parts of the flue held in this manner vertically can be rotated to give the divisions for the number of holes required. There are four drilling spindles fixed vertical on two horizontal beams which can be traversed to or from the flue. The spindles are adjustable, and provision is made for a free supply of lubricant, so that they may be run at a high speed. We understand that about an hour is required to drill a joint, and it is claimed that it is done more accurately than by the common method, the fact that the flue is held close to where the drills are to act, instead of by a more or less remote part, conducing to this end. It is certainly a compact machine, and the flues being held vertically, they can be allowed to descend partly into a pit, so that shop space is economised. The spindles are designed so that the shortest flues used may be drilled. We understand that several of these machines are already at work with satisfactory results.



LANG'S LATHE BED



ORDINARY LATHE BED

JOHN LANG AND SONS.

We have become so accustomed to a few well-known designs of lathe beds, and those designs have been so widely accepted, that few novelties could arrest our attention more than an entirely new development in this direction. Many people knew that John Lang and Sons were introducing a new bed, and they will be glad of the opportunity which the Exhibition affords of studying the design. The makers have had lathes made to the new drawings at use in their works for many months, and they are so satisfied that it effects an important improvement, that they are taking steps to make all their lathe beds of this pattern for the future. The object they have had before them in introducing this design has been to reduce the play that must inevitably exist when two parts are a free sliding fit. A double course has been taken to obtain this end. The proportion of width to length of the guiding part of the saddles has been reduced, and the vee edge has been replaced by flat sides. The change, and what it means, will be at once apparent from the two sketches annexed, of which the first shows the usual form of bed and saddle, and the second the Lang design. It will be observed that in the latter the guiding faces are D and C, and that the fit on the latter is adjusted by a long taper wedge shown in the plan. The back part of the saddle is perfectly free at G; it rests on the two surfaces A and B, and the back centre is guided by the one-sided vee marked K. Two plates, H and I, counteract any tendency of the saddle to lift. A rough experiment was made at the works to test the efficiency of this form of bed. A bar extending about 2ft. horizontally from the front of the lathe was bolted to the saddle. A rope was fixed at its extreme end and passed over a pulley. The saddle was then left free to slide, and it was found that whereas by attaching a suitable weight to the rope the saddle could be moved, a very much heavier weight had to be used if the experiment was repeated with an ordinary saddle, and there was an evident inclination to seize. An incidental advantage of this form of bed is also shown by the sketches. The position of the lead screw in a lathe is settled by certain considerations and by certain structural conditions. That it should be as near as

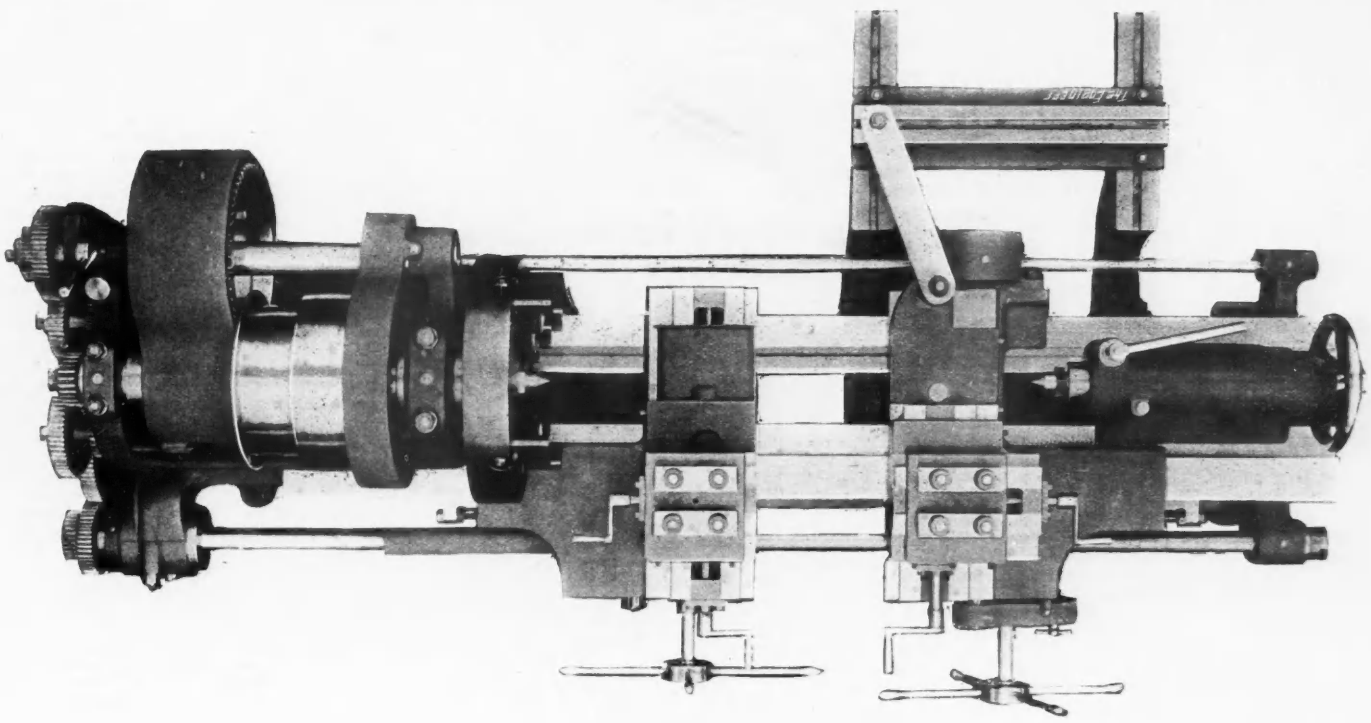
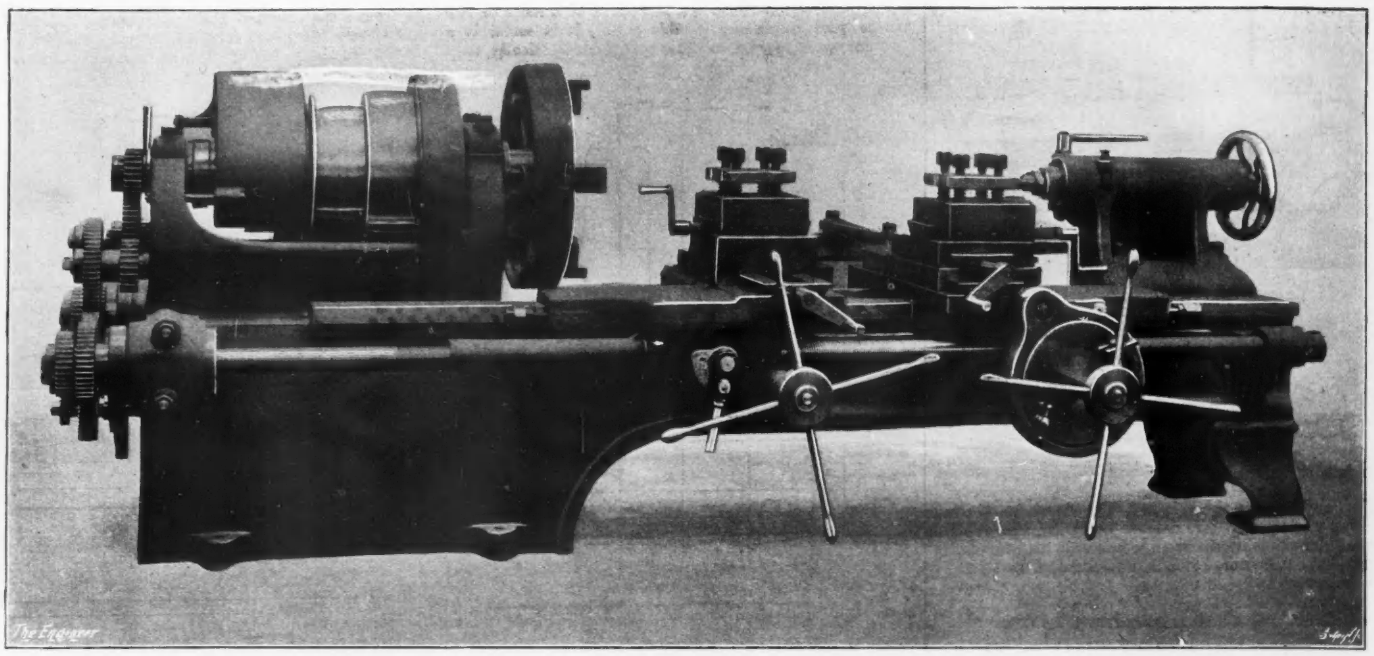


Fig 27—LARGE SHELL TURNING LATHE, PLAN, BY JOHN LANG AND CO.

DUPLEX LATHE FOR TURNING SHELLS

JOHN LANG AND SONS, JOHNSTONE, ENGINEERS



possible to the centre line of sliding motion is obvious, but if it is put between the shears it is almost impossible to keep it clean and inconvenient to get at. It is, therefore, generally put outside, and the structural conditions to which we have referred necessitate its being a certain number of inches from the front of the shears. In the two sketches its relative position to the bed is the same, but it will be noticed that the distance F from the centre line of sliding is much less with the new bed than the old. There is consequently less tendency to twist the saddle. Exception might be taken to the statement above that the lead screw should be as near as possible to the centre line of sliding. Its ideal position would be directly behind or directly beneath the cutting edge. This is a position, of course, incapable of realisation, because it would have to change with every diameter of work. The fact, however, would appear to reduce the importance of the position of the lead screw, but it gives the advantage to Lang's bed, for in all probability the line of thrust resisting the travel of the saddle would more often fall near the centre line of sliding in this lathe than in the ordinary type, and there is on this account less tendency to twist the saddle. The flat sides for guiding is an unquestionable improvement. It would, we think, be difficult to give thoroughly sound reasons for the adherence to dovetail shears at the present day. Possibly fashion has something to do with it, and cost of manufacture a great deal. That the present is the easiest method of keeping the saddle down on the bed is open to doubt, and there are scores of other machines and heavy lathes which are made with square shears.

John Lang and Sons show their new form of bed adapted to several lathes, but in none does it appear to greater advantage than in a heavy lathe for shell-turning, one of a number made for Sir William Armstrong, Whitworth, and Co.'s new works at Scotswood, near Elswick. Two saddles are fitted on this lathe. They are both one-sided, and being right and left-handed, the tools can be brought almost together. The lathe is so arranged that the extension of the saddle in one passes the poppet head, and in the other it clears the loose headstock. Consequently the tools can be brought very close to the face plate and the back centre respectively. The latter saddle is provided with a radius bar for turning the ogival head. We give above two views of this lathe, which show clearly how kindly the Lang bed lends itself to the duplex treatment.

Fig. 28—8¼in SCREW-CUTTING LATHE

We illustrate also, Fig. 28, a typical engineers' sliding, surfacing, and screw-cutting lathe exhibited by this firm. We do not know that any special description is required, and we give it more to show a complete lathe provided with the new bed than for any other reason. It represents a good type of British lathe, and is the outcome of accumulated experience of what is required by the general engineer. The gear throughout, including the rack, is cut from the solid; the spindle is of hard crucible steel ground truly cylindrical, and runs in parallel gun-metal bearings, which are carefully bedded into the headstock casting, the fitted part being rectangular. The lead screw is ½in. pitch. It is gripped by a double nut, top and bottom, for screw cutting. The screw is reserved for chasing, sliding being effected by a rack. The self-acting traverse is put in by clamping the disc on the handle to a spur wheel driven by a pinion from the back shaft. The rate of feed can be altered whilst running by simply shifting the lever in front of the headstock. The well-known method of the sliding feather, claimed to have originated with this firm, is employed. The feeds are $\frac{1}{32}$in., $\frac{1}{20}$in., and $\frac{1}{12}$in. per revolution of the spindle. The pan shown fitted to this lathe is a special addition. The form of the guards on the headgear is worth noticing. They cover the teeth on the sides as well as the top, and are as effective as the flanges or the much-talked-about lug on the bed in preventing the belt by any chance from entering the gear.

From lack of space we are unable to conclude our description of John Lang and Sons' interesting exhibit here, but in the current number of THE ENGINEER we illustrate and describe some more of their machines. Kendal and Gent and Loudon Brothers are in the same case, and we are also compelled to hold over descriptions of some British-made tools shown by Burton, Griffith, and Co., and Selig, Sonnenthal, and Co., till future issues.

Boilerplate

The Engineer.

Registered as a Newspaper

OFFICE FOR ADVERTISEMENTS AND PUBLICATION, 33, NORFOLK STREET, STRAND, W.C.

VOL. XCI.—No. 2374] LONDON: FRIDAY EVENING, JUNE 28, 1901. [PRICE { WITH SUPPLEMENT } SIXPENCE

India-office, Whitehall,
26th June, 1901.

The Secretary of State for

India in Council is prepared to receive TENDERS from such persons as may be willing to supply

1. BRASS BOILER TUBES.
2. COPPER PLATES.

The conditions of contract may be obtained on application to the Director-General of Stores, India-office, Whitehall, S.W., and Tenders are to be delivered at that office by Two o'clock p.m. on Tuesday, the 9th July, 1901, after which time no Tender will be received.

E. GRANT BURLS,
Director-General of Stores.
2351

PATENTS, DESIGNS, AND TRADE MARKS ACTS, 1883 to 1888.

Notice is Hereby Given that

ROBERT SMITH, of Clyde View, Royal-street, Gobrock, Renfrewshire, Scotland, and THOMAS HILL, of Robertson-street, Glasgow, Lanarkshire, Scotland, have APPLIED for LEAVE to AMEND the Specification of Letters Patent No. 1905 of 1899, granted to them for "Improvements in Steam Generators or Boilers."

Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents) issued on the 19th June, 1901.

Any person or persons may give notice of opposition to the amendment (on Form G) at the Patent-office, 25, Southampton-buildings, London, W.C., within one calendar month from the date of the said Journal.

C. N. DALTON,
Comptroller-General.
2252

Amalgamated Society of General

TOOLMAKERS, ENGINEERS, AND MACHINISTS.—NOTICE is HEREBY GIVEN that Messrs. AUSTIN GRAY and CO., of Blatic-chambers, 50, Wellington-street, Glasgow, have NO AUTHORITY to SOLICIT ORDERS for or on behalf of the Amalgamated Society of General Tool Makers, Engineers, and Machinists, whose registered office is at No. 32, Great Charles-street, in the City of Birmingham, or on behalf of the Secretary, Mr. William Frederick Beston. Any person or persons who have given orders for advertisements are requested to communicate with me the undersigned.

Dated 22nd June, 1901.

ARTHUR S. O'CONNOR,
25, Bennett's-hill, Birmingham. 2263

Municipal Technical School,

LEICESTER.

WANTED, in September, an INSTRUCTOR in Engineering Subjects. Day and evening classes. Salary £150 per annum. Apply to

ALFRED T. NEWBY,
Secretary.
2264

The Committee of the Municipal

School of Technology, Manchester, to be opened in September next, invite APPLICATIONS from gentlemen qualified to take the POSITION of HEAD of the PHYSICS and ELECTRICAL ENGINEERING DEPARTMENT.

Stipend £500 per annum.

The gentleman appointed will have the title of Professor and rank as a Member of the Board of Studies.

He will have the assistance of an efficient staff.

Acceptable candidates, in addition to satisfactory theoretical attainments, must have had an efficient training and experience in some important branch of practical electrical engineering.

Applications, with copies of a limited number of recent testimonials, should be addressed, not later than Saturday, July 6th, to the undersigned, from whom further information as to the conditions of the appointment may be obtained.

J. H. REYNOLDS,
Principal.
Princess-street, Manchester,
June 17th, 1901. 2314

Barrow-on-Soar Rural District

COUNCIL.

NEWTOWN LINFORD (LEICESTERSHIRE).

SEWERAGE AND SEWAGE DISPOSAL.

The above Council invite TENDERS from competent Contractors, for the EXECUTION of WORKS of SEWERAGE and SEWAGE DISPOSAL, for the parish of Newtown Linford, as follows:—

CONTRACT No. 1.—SEWERAGE WORKS.

Providing and Laying about 1630 Lineal Yards of 12in., 9in., and 6in. Earthenware Pipe Sewers, and Drain Connections, together with Manholes, Flushing Chambers, and other works in connection therewith.

CONTRACT No. 2.—SEWAGE DISPOSAL WORKS.

Providing all Material and Building Cottage, Engine House, Pump Chamber, Laying Rising Main and Outfall Sewer to the Sewage Farm, together with Manholes, Chambers, Pumping Machinery, Screens, Valves, Sluices, &c.

Specification, conditions of contract, and drawings may be seen on application to Mr. F. Griffith, M. Inst. C.E., Water Works Office, Bowling Green-street, Leicester, and schedule of quantities may be obtained on deposit of £2 2s., which will be refunded on the receipt of a bonâ fide Tender, and the return of the documents.

Tenders are to be sent to the undersigned not later than Monday, 15th July, 1901.

The Council do not bind themselves to accept the lowest or any Tender.

Dated this 24th June, 1901.

A. C. MEAKIN,
Clerk to the Council.
Union Offices,
Mountsorrel, Leicestershire. 2308

Bengal-Nagpur Railway Company, LIMITED.

The Directors of the Bengal-Nagpur Railway Company are prepared to receive TENDERS for the SUPPLY of TEN SIX-WHEEL COUPLED LOCOMOTIVES for a 2ft. 6in. gauge railway.

A general drawing and specification of the locomotives can be seen, and further details can be obtained, on application at the office of Sir John Wolfe Barry, 21, Delahay-street, Westminster, S.W., between the hours of 11 a.m. and 4 p.m., on and after Monday, the 24th instant, when also copies of the drawing and specification and form of Tender can be obtained on payment of a fee of £2 2s.

Tenders, which must be endorsed "Tender for 2ft. 6in. Gauge Locomotives," must be delivered at the office of the Company, No. 132, Gresham House, Old Broad-street, E.C., not later than Noon, on Monday, the 15th July, 1901.

The Directors do not bind themselves to accept the lowest or any Tender.

By order of the Board,
ROBERT MILLER,
Managing Director.
2272

Borough of Southwark (Parish

OF ST. MARY, NEWINGTON).

ELECTRICITY SUPPLY EXTENSION

CONTRACT No. 15.

The Electric Light Committee of the Metropolitan Borough of Southwark are desirous of receiving TENDERS for the SUPPLY and ERECTION of TWO ADDITIONAL PANELS to the MAIN SWITCHBOARD at their Electric Light Station, Penrose street, Walworth-road, S.E.

Specifications and forms of Tender can be obtained on and after the 26th instant, at the office of the Engineers, Messrs. Kincaid, Waller, and Manville, 29, Gt. George-street, Westminster, S.W., on payment of a fee of Five Guineas, which sum will be returned on receipt of a bonâ fide Tender.

The Corporation do not bind themselves to accept the lowest or any Tender, and the contractor whose Tender is accepted shall enter into a formal agreement, under seal, with sufficient sureties, for the due fulfilment of his contract.

Sealed Tenders, endorsed "Electricity Supply—Tender for Contract No. 15," to be sent to me on or before noon on the 10th day of July, 1901

By order,
J. A. JOHNSON,
Town Clerk.
Town Hall, Walworth-road, S.E.,
25th June, 1901. 2316

Bombay, Baroda, and Central

INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to noon on Tuesday, the 9th July, TENDERS for the SUPPLY of the following STORES, viz.:—

1. Miscellaneous Tools and Stores.	2. Oil Wagons. 3. Wagon Buffers.

Tenders must be made on forms, copies of which, with specifications, can be obtained at these offices on payment of 21s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

T. W. WOOD,
Secretary.

Offices, Gloucester House,
Bishopsgate-street Without,
London, E.C., 24th June, 1901. 2311

Borough of Lowestoft, Suffolk.

SEA DEFENCE WORKS.

The Council invite TENDERS for the CONSTRUCTION of a SEA WALL, about 5692ft. in length, upon the North Denes, together with the erection of 20 TIMBER GROYNES on the North Beach and 2 GROYNES with Revetments and other works on the South Beach at Lowestoft, in the county of Suffolk.

Plans and specifications may be seen on and after July 1st, 1901, at the office of the Town Clerk at Lowestoft, or at the office of the Consulting Engineer to the Corporation, W. T. Douglass, Esq., 15, Victoria-street, Westminster, London, S.W., where also copies of the bills of quantities and form of Tender may be obtained on payment of a deposit of £2 2s., which sum will be returned on receipt of a bonâ fide Tender.

Copies of the plans may be obtained from the Consulting Engineer on payment of the sum of £1 1s., which sum will not be returned.

Sealed Tenders, which will only be received upon the form supplied, endorsed "Tender for Sea Defence Works," to be delivered to the Town Clerk at his office at Lowestoft, in the county of Suffolk, at or before Noon on the 17th day of July, 1901.

The Council do not bind themselves to accept the lowest or any Tender.

By order,
(Signed) R. BEATTIE NICHOLSON,
Town Clerk.
Town Clerk's Office,
Lowestoft, Suffolk,
24th June, 1901. 2277

Bury and District Waterworks.

HASLINGDEN PUMPING STATION.

The Bury and District Joint Water Board invites TENDERS for each of the following contracts:—

CONTRACT No. 1.

RESERVOIR.—The construction of a covered service reservoir to hold 500,000 gallons, at Slates, Haslingden.

CONTRACT No. 2.

LAYING MAINS.—Cutting tracks for, and laying, and jointing 3413 lineal yards of 15in., 725 lineal yards of 12in., and 470 lineal yards of 9in. diameter cast iron pipes.

CONTRACT No. 3.

CAST IRON PIPES.—Providing and delivering at Haslingden or Rawtenstall stations, 817 tons of cast iron pipes 15in., 12in., and 9in. diameter, and 50 tons of special castings.

CONTRACT No. 4.

ENGINES AND PUMPS.—Providing and erecting two sets of engines and pumps, each capable of raising 450 gallons of water per minute to a height of 166ft., together with two Lancashire boilers and all accessories.

CONTRACT No. 5.

ENGINE-HOUSE.—Erecting an engine-house and boiler-house, and building boundary walls.

CONTRACT No. 6.

VALVES, &c.—Providing and delivering at Haslingden or Rawtenstall stations, air valves, sluice valves reflux valves, surface boxes, &c.

Drawings may be seen and copies of the specifications, bills of quantities, and forms of Tender obtained at the offices of the Engineer to the Board, Mr. J. Cartwright, Peel Chambers, Market-place, Bury, on and after Friday, the 28th June, upon deposit of Two Pounds for each contract, which sum will be returned on receipt of a bonâ fide Tender and other documents supplied.

Sealed Tenders, endorsed "Haslingden Pumping Station, Tender for Contract No. —," to be lodged with the undersigned not later than Tuesday, 16th July next.

JOHN HASLAM,
Clerk to the Board.
Bank-street, Bury,
22nd June, 1901. 2265

City of Birmingham.—To Build-

ING CONTRACTORS AND OTHERS.

SMALL HEATH BRIDGE.

CONTRACT No. 1.

The Public Works Committee are prepared to receive TENDERS for the CONSTRUCTION of the APPROACHES and BRIDGE over Canal.

The drawings and specification may be inspected and quantities and forms of Tender obtained on deposit of Five Guineas (which will be returned on receipt of a bonâ fide Tender) at the undermentioned office.

Tenders are to be sent in not later than 10 a.m. on 8th July, endorsed "Small Heath Bridge, Contract No. 1."

The Tender of any firm or person paying less than the minimum standard rate of wages current in the district will not be accepted.

The lowest or any Tender will not necessarily be accepted.

JOHN PRICE, M. Inst. C.E.,
City Engineer and Surveyor.
Council House, Birmingham,
24th June, 1901. 2274

Caledonian Railway Company.

GRANGEMOUTH DOCK EXTENSION.

80ft. CAISSON GATE.

The Directors of the Caledonian Railway Company are prepared to receive TENDERS for the CONSTRUCTION and ERECTION complete at Grangemouth of an 80ft. WROUGHT IRON and STEEL CAISSON GATE.

The contract drawings and specification may be seen at the offices of Sir John Wolfe Barry, K.C.B., 21, Delahay-street, Westminster, between the hours of 11 a.m. and 4 p.m. on and after Monday, the 8th July next, where also copies of the contract drawings, specification, schedule of quantities, and form of Tender may be obtained on payment of Three Guineas.

Tenders, endorsed "Tender for Caisson Gate," must be delivered at the office of the Secretary, Caledonian Railway, Glasgow, at or before 10 a.m. on Monday, the 29th July, 1901.

The Directors do not bind themselves to accept the lowest or any Tender.

J. BLACKBURN,
Secretary.
Caledonian Railway Company's Offices,
302, Buchanan-street, Glasgow,
21st June, 1901. 2255

Caledonian Railway Company.

GRANGEMOUTH DOCK EXTENSION.

STEEL SWING BRIDGE.

The Directors of the Caledonian Railway Company are prepared to receive TENDERS for the CONSTRUCTION and ERECTION complete at Grangemouth of a STEEL SWING BRIDGE measuring 161ft. in length over all, together with the necessary Hydraulic Machinery for operating the same.

The contract drawings and specification may be seen at the offices of Sir John Wolfe Barry, K.C.B., 21, Delahay-street, Westminster, between the hours of 11 a.m. and 4 p.m. on and after Monday, the 8th July next, where also copies of the contract drawings, specification, schedule of quantities, and form of Tender may be obtained on payment of Three Guineas.

Tenders, endorsed "Tender for Swing Bridge," must be delivered at the office of the Secretary, Caledonian Railway, Glasgow, at or before 10 a.m. on Monday, the 29th July, 1901.

The Directors do not bind themselves to accept the lowest or any Tender.

J. BLACKBURN,
Secretary.
Caledonian Railway Company's Offices,
302, Buchanan-street, Glasgow,
21st June, 1901. 2256

Chelsea Borough Council

PUBLIC BATHS DEPARTMENT.

The Public Baths Committee of the Council invite COMPETITIVE DESIGNS (to be sent in by 1st October next) for proposed new BATHS in King's-road, Chelsea.

The following premiums are offered, viz.:—For the one placed first in the order of merit, One Hundred Guineas; for the one placed second, Fifty Guineas; and for the one placed third, Thirty Guineas.

If the architect to whom the first or other premium is awarded be elected to execute the work, then the premium will be merged in the amount payable under the contract.

Particulars of the instructions to competing architects and a plan of the site, at a charge of £1 1s. (which will be returned to persons sending in bonâ fide designs), can be obtained at the OFFICE of the COMMITTEE, 171, King's-road, Chelsea. 2180

Cornwall County Asylum.—Pro-

POSED EXTENSIONS.

TO BUILDERS AND CONTRACTORS.

The Visiting Committee invite TENDERS from competent contractors for the ERECTION and COMPLETION of EXTENSIONS and ADDITIONS to the present COUNTY ASYLUM BUILDINGS at Bodmin, Cornwall, comprising separate detached blocks for Sick and Infirm, Recent and Acute, Chronic Epileptic and other classifications of patients, together with Assistant Medical Officers' Residence, Waiting-rooms, Recreation and Dining Hall, Kitchens, Offices, Staff Quarters, Workshops, Stores, Boiler-house, &c., according to drawings, specifications, &c., prepared by Mr. Silvanus Trevail, F.R.I.B.A., Architect, of Truro and Palace Chambers, Westminster, and approved by his Majesty's Commissioners in Lunacy and Secretary of State for the Home Department.

Persons desirous of tendering are requested to send their names and addresses to the undersigned forthwith, accompanied by a deposit of Five Guineas (which will be returned on receipt of a bonâ fide Tender), when a copy of the bills of quantities, conditions of contract, and the necessary forms and instructions for Tendering will be supplied.

The Visiting Committee reserve to themselves the right of refusing to accept the lowest or any Tender or Tenders, and will pay no expenses in connection with the submission of any Tender.

The person whose Tender is accepted will be required to enter into a contract with the Committee for the due performance and completion of the work within about three years from the date thereof.

By Section 256 Sub-section 1 of the Lunacy Act, 1890, 53 Vic. c. 5, "Every person entering into a contract with the Visiting Committee shall give sufficient security for due performance of the contract."

By order,
ROBERT P. EDYVEAN,
Clerk to the Committee.
Dated Bodmin, 25th May, 1901. 1896

Corporation of Calcutta.

WATERWORKS DEPARTMENT.

NEW PUMPING MACHINERY.

The Commissioners are prepared to receive TENDERS for the SUPPLY, DELIVERY, and ERECTION of a new PUMPING PLANT at their Pulta Pumping Station, near Barrackpore. The Plant will consist of Two Pumping Engines and Four Steam Boilers, and will be capable of delivering one million gallons of water per hour to a maximum height of 35ft. (thirty-three feet.)

Specification, general conditions, and plan of the pumping station may be obtained upon application at the office of this paper by any bonâ fide manufacturer of pumping engines.

Tenders, endorsed "Tender for Pulta Pumping Machinery," and addressed the Vice-Chairman of the Corporation, must be delivered at the Municipal Office, Calcutta, on or before the 2nd day of September, 1901.

FRED. GAINSFORD,
Officiating Secretary to the Corporation.
28th May, 1901. 2170

County Borough of Rochdale.

TO CONTRACTORS.

The Rochdale Corporation invite TENDERS for the STEEL-WORK, consisting of STEEL PLATE GIRDERS, ROLLED STEEL JOISTS, and ARCHED PLATING (about 28 tons in all) required in connection with the Widening of Spotland Bridge, within the said borough.

Plans may be seen, and copies of the specification, form of Tender and quantities, and further particulars, may be obtained on and after Thursday, July 4th, on payment of a deposit of 10s. (which will be returned on receipt of a bonâ fide Tender), at the office of Mr. S. S. Platt, M. Inst. C.E., Borough Surveyor, Town Hall, Rochdale.

Tenders, endorsed "Steelwork, Spotland Bridge," to be delivered at my office not later than 5 p.m. on Tuesday, July 9th.

By order,
JAMES LEACH,
Town Clerk.
Town Hall, Rochdale,
June 28th, 1901. 2336

East Indian Railway.—The East

Indian Railway Company is prepared to receive TENDERS for the SUPPLY and DELIVERY of—

STEEL and IRON WORK for an OVERBRIDGE, as per specification to be seen at the Company's Offices.

Tenders are to be sent to the undersigned, marked "Tender for an Overbridge," not later than One o'clock p.m. on Wednesday, the 17th day of July proximo.

The Company reserves to itself the right to divide the order, also to decline any Tender without assigning a reason, and does not bind itself to accept the lowest or any Tender.

For each specification a fee of £1 1s. is charged, which cannot under any circumstances be returned.

By order,
C. W. YOUNG,
Secretary.
Nicholas-lane, London, E.C.,
27th June, 1901. 2369

Great Eastern Railway.—Con-

TRACTS FOR BESSEMER STEEL RAILS.

The Directors of this Company are prepared to receive TENDERS for the SUPPLY of BESSEMER STEEL RAILS.

Form of Tender, specification, and drawing, may be had on application to the Secretary's Office, Liverpool-street Terminus, E.C.

Tenders, endorsed "Tender for Bessemer Steel Rails," to be forwarded by post, in the envelope provided by the Company, to the undersigned, so as to be received not later than 10 a.m., 5th July, 1901.

Tenders which do not comply in every respect with the Company's terms, conditions, schedule, specification, and drawing, will not be considered.

The Directors do not bind themselves to accept the lowest or any Tender.

W. H. PEPPERCORNE,
Secretary.
Liverpool-street Terminus, London, E.C.,
21st June, 1901. 2271

Heanor Urban District Council.

TO COLLIERY PROPRIETORS, MACHINERY BROKERS, AND OTHERS.

TENDERS are invited for the BOILERS, PUMPS, CHAINS, CRABS, TOOLS, and other PLANT, now at the Smalley Waterworks, situate two miles from Coxbend Station, on the Derby and Ripley line of the Midland Railway.

Catalogues and further particulars may be had upon application to the undersigned, to whom Tenders must be sent on or before Wednesday, the 31st day of July, 1901.

The Council do not bind themselves to accept the highest or any Tender.

By order,
JOHN HOLBROOK,
Surveyor.
2346

The Wantage Engineering Com-

PANY, LIMITED, are DESIROUS of RECEIVING TENDERS for the entire EQUIPMENT of their new MACHINERY SHOPS. No Tender for supplying new machinery can be considered unless it is accompanied by a Tender for the purchase of the present machinery now running in the company's workshops. This machinery may be viewed at any time at the works at Wantage, Berks. 2301

Hurst Urban District Council.

NEW TRAMWAYS.

CONTRACT No. 2.

Notice is hereby given that the above District Council are prepared to receive TENDERS from such persons as may be willing to enter into a contract for the CONSTRUCTION of the PERMANENT WAY of the TRAMWAYS, including the supply of Labour and Material (except granite setts, which will be provided by the Council) for the Concrete Foundations and other contingent work.

Also the FIXING of Grooved Steel Girder TRAMWAY RAILS, POINTS and CROSSINGS, FISH-PLATES, TIE-BARS, BOLTS and NUTS, together with the Material and Labour required in the Electric Copper Bonding of the rails, points, and crossings, &c., and all other work connected therewith.

Plans and drawings may be seen, and specifications, conditions of contract, bills of quantities, and forms of Tender, may be obtained at the office of the undersigned on payment of £2 2s., which will be returned on receipt of a bonâ fide Tender.

Sealed Tenders, endorsed "Permanent Way," must be delivered at the office of Mr. Jno. Whitworth, Law Clerk to the Council, Booth-street-chambers, Ashton-under-Lyne, on or before Twelve o'clock at noon on Friday, July 5th, 1901.

The Council do not bind themselves to accept the lowest or any Tender.

EDWARD GARSIDE, Assoc. M. Inst. C.E.
Town Hall-chambers,
Ashton-under-Lyne,
June 15th, 1901. 2173

Rural District Council of

BUCKINGHAM.

TO CONTRACTORS AND OTHERS.

WORKS OF WATER SUPPLY.

The above Council invite TENDERS for the CONSTRUCTION of WORKS of WATER SUPPLY for the parishes of Charndon and Twyford.

Specifications and forms of Tender can be obtained on application to the Engineer, Mr. Geo. Roberts, Deanshanger, Stony Stratford, or to the undersigned at a charge of £1 1s., to be returned on receipt of a bonâ fide Tender.

Tenders, sealed and endorsed "Charndon Waterworks" or "Twyford Waterworks," must be delivered at my office, 25, West-street, Buckingham, on or before the 19th day of July, 1901.

The Council do not bind themselves to accept the lowest or any Tender.

THOMAS R. HEARN,
Clerk.
Buckingham, 25th June, 1901. 2285

Shrewsbury Corporation.—

KINGSLAND WATER SUPPLY.

TO ENGINEERS.

The Shrewsbury Corporation are prepared to receive TENDERS for the MANUFACTURE, DELIVERY, ERECTION and SETTING TO WORK of TWO SETS of 3-THROW PLUNGER PUMPS, with air vessels and pipe connections complete, and an ACCUMULATOR with valves, guides, and other appurtenances.

The whole of the machinery is to be erected within the structure carrying the existing water tower, near St. Mary's-street, Shrewsbury, and is to be in accordance with the plans, drawings, and specification prepared by Messrs. John Taylor, Sons, and Santo Crimp, Civil Engineers, 27, Great George-street, Westminster.

Copies of the specification and prints of the drawings can be obtained at the offices of the engineers upon depositing £5 (cheque only), which will be returned upon the receipt of a bonâ fide Tender.

Sealed Tenders, endorsed "Shrewsbury Water, Tender for Pumping Plant," and addressed to the Town Clerk, are to be delivered at the Shire Hall, Shrewsbury, on or before Thursday, the 18th day of July, 1901.

The Corporation do not bind themselves to accept the lowest or any Tender.

By order,
HENRY CHARLES CLARKE,
Town Clerk.
Shrewsbury, 19th June, 1901. 22x7

South-West Suburban Water

COMPANY.

The Directors of the above Company invite TENDERS for the SUPPLY and ERECTION of a WATER TOWER at Southall, with CIRCULAR STEEL TANK, to contain 300,000 gallons, at an elevation of 60ft. above ground level.

Plans may be seen, and specification and form of Tender obtained, on and after Monday, July 1st, at the office, R. St. George-Moore, M. Inst. C.E., Engineer to the Company, 17, Victoria-street, Westminster, upon deposit of a £5 Bank of England note (which will be returned on receipt of a bonâ fide Tender).

Tenders to be delivered at the Company's offices at 17, Victoria-street, Westminster, and endorsed "Tender for Water Tower at Southall," before 11 a.m. on Monday, July 22nd.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board.
June 26th, 1901. 2334

TO ENGINEERS AND CONTRACTORS.

The Guardians of the Kingston

Union invite TENDERS for the SUPPLY and ERECTION of WROUGHT IRON and STEEL BALCONIES to the Infirmaries at the Workhouse, Kingston-on-Thames.

Plans and specification may be seen, and form of Tender obtained, on application to Mr. Willm. H. Hope, C.E., Architect and Surveyor, Hampton Wick.

Tenders to be delivered to me, the undersigned, endorsed "Tender for Balconies," not later than Ten o'clock, Tuesday morning, the 16th proximo.

The Board do not bind themselves to accept the lowest or any Tender.

Signed, JAMES EDGELL, Solicitor,
Clerk to the Guardians.
Union Offices, Kingston-on-Thames,
25th June, 1901. 2323

The Rural District Council of

GODSTONE.

BARFIELDS SEWERAGE AND SEWAGE DISPOSAL.

TO SEWERAGE CONTRACTORS AND OTHERS

The District Council are desirous of receiving TENDERS for CONTRACT A., the Providing and Laying of 1338 lineal yards of 6in., 7in., 9in., and 9in. Stoneware Pipe Sewers; the Construction of Manholes, Flushing Manholes, and Lampholes, &c.; the Construction of a Screen Chamber, Storage Reservoir, Engine House, and Pump Well; the Providing and Erecting Duplicate Gas Engines, Ram Pumps, Foundations, and other works in connection with same; and the Providing and Laying of 435 lineal yards of 6in. Cast Iron Pumping Main.

The drawings, specifications, &c., for the above may be seen at the office of Mr. T. C. Barralet, Surveyor to the Council, at New Oxted, on and after the 22nd day of June, 1901, from 10 a.m. to 4 p.m. each day except Saturdays.

Copies of the specification, quantities, and form of Tender, may be obtained from the Engineers, Messrs. Fairbank and Son, C.E., 13, Lendal, York, on deposit of £3 3s. This sum will, after the Council shall have come to a decision on the Tenders, but not before, be returned to each person tendering, providing he shall have sent in a bonâ fide Tender and shall not have withdrawn the same, and shall have returned the documents lent to him for the purpose of making up his Tender.

Sealed Tenders, endorsed "Tenders for Contract A," must reach the undersigned on or before the 16th day of July, 1901.

The Council do not bind themselves to accept the lowest or any Tender, nor will they make any allowance for estimate.

By order,
EVELYN ALSTON HEAD,
Clerk.
East Grinstead, Sussex,
19th June, 1901. 2235

For continuation of Official Advertisements see page II.

For continuation of Small Advertisements see pages II., III., IV., *and* LXXVIII.

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The Delhi, Umballa, Kalka RAILWAY COMPANY, LIMITED.

The Directors of the Delhi, Umballa, Kalka Railway Company, Limited, are prepared to receive TENDERS for the SUPPLY and DELIVERY of—

W.I. FENCING MATERIAL
GALVANISED STRAND WIRE for FENCING.

as per specification to be obtained at the Company's Offices. For each specification a fee of 10s. 6d. is charged, which amount will not be returned.

Tenders to be sent to the undersigned, marked "Tender for W.I. Fencing Material" (or as the case may be), not later than Noon on Friday, the 5th day of July, 1901.

The Directors do not bind themselves to accept the lowest or any Tender.

By order,
W. McFARLANE,
Secretary.

17, Victoria-street, Westminster, S.W.,
24th June, 1901. 2292

The Rohilkund and Kumaon RAILWAY COMPANY, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

800 PRS. WHEELS and AXLES.

Specification, with form of Tender and Company's general conditions of contract, may be obtained from the Company's Offices on payment of a fee of 10s. each (which will not be returned).

Tenders to be delivered in sealed envelopes addressed to the undersigned, and marked on the outside "Tender for Wheels and Axles," and lodged not later than noon on Monday, the 8th day of July, 1901.

The Directors do not bind themselves to accept the lowest or any Tender.

By order of the Board,
E. L. MARRYAT,
Managing Director.

Company's Offices,
237, Gresham House, Old Broad-street,
London, E.C.,
27th June, 1901. 2370

The South Indian Railway Com-

PANY, Limited, is prepared to receive TENDERS for the SUPPLY of :—

(1) GENERAL STORES, comprising Hardware, Iron, Steel, Metals, Leather Goods, Oils and Colours, India-rubber Goods, and Sundries.
(2) LOCOMOTIVE and ENGINEERING STORES, comprising Copper and Steel Plates, Engine Tires, Brass Tubes, Springs, Buffers, and other Stores.
(3) STATIONARY, comprising Books, Paper, Envelopes Ink, Tickets, and Sundries.
(4) ROOFING, 500ft. by 25ft., covered with Galvanised Iron.

Specifications and forms of Tender may be obtained at the Company's offices on and after Monday, 1st July.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, and marked "Tender for Stores," or as the case may be, must be left with the undersigned not later than Twelve o'clock noon of Tuesday, the 16th day of July, 1901.

The Company is not bound to accept the lowest or any Tender.

A charge (which will not be returned) will be made of 20s. for each copy of specifications (1) and (3), and of 10s. for each copy of specifications (2) and (4).

Copies of the drawings may be obtained at the office of Sir George B. Bruce, 3, Victoria-street, Westminster, on payment of 5s. per sheet.

By order.
HENRY W. NOTMAN,
Managing Director.

Company's Offices:
55, Gracechurch-street, London, E.C.,
28th June, 1901. 2368

Wigan Union.—Valuer.—The

Guardians of the Wigan Union invite APPLICATIONS for the POST of RATING SURVEYOR and VALUER, whose duty shall be to assist the Assessment Committee, and through them the Overseers, in the assessment of the various properties throughout the Union, and to make reports to the Committee on appeals against assessments.

The salary on appointment will be at the rate of £500 per annum.

The person appointed must find all necessary clerical assistance, but the Guardians will provide office accommodation and office requisites, and will also pay necessary travelling expenses.

The person appointed will be required to devote the whole of is time to his duties, and must be prepared to give a bond in he sum of £500 for their due performance.

All valuations and other documents made by the Valuer shall e the property of the Committee.

The appointment will be determinable by six months' notice on either side.

The Guardians will require proof of the following qualifications :—Thorough knowledge of Land and Mine Surveying, Building Construction, and Mechanical Engineering.

The possession of Science Certificates for any of the foregoing subjects, together with a due length of experience, will be taken into consideration in the selection from the candidates offering themselves.

The appointment will be made subject to the provisions of the Poor Law Officers' Superannuation Act, 1896.

Applications, stating age (which must not be less than 30 years nor more than 45 years), and experience, and accompanied by not more than three recent testimonials, will be received by me, the undersigned, not later than the 25th day of June, 1901.

Personal canvassing the Guardians will be a disqualification, and applications and testimonials must only be sent to the Clerk.

By order of the Board,
HENRY ACKERLEY,
Clerk.

9, Victoria-buildings,
King-street, Wigan,
30th May, 1901. 1950

Wanted, a Junior Draughtsman

with experience of steel construction.—Apply, by etter, stating qualifications, experience, and salary required, o X. Y. Z., 28, Victoria-street, S.W. 2288

Wanted, a Smart and Steady

MAN to Take Charge of Brass Foundry in an Engineering Works in the Midlands, which is equipped with the most modern appliances for the rapid and economical production of repetition and general work. State age, experience, and wages expected, giving copies of testimonials, &c., which will be treated as confidential.—Address, 2093, Engineer Office, 33, Norfolk-street, Strand, W.C. 2093

Wanted, an Energetic Young

MAN with a thorough knowledge of Timber of all kinds to act as FOREMAN in the works of an Electric Timber Seasoning Co. A slight knowledge of electricity would be an advantage. This is an excellent opening for a young man, as he would ultimately, if found suitable, be given the post of works manager.—Address, stating age, experience, and salary required, P978, Engineer Office, 33, Norfolk-street, Strand, W.C. Copies of references only. P978

Wanted, at all Industrial Places

by leading firm, REPRESENTATIVES, to push) sale of high-class and well-known articles for steam engines, steam pumps, &c.; must be well introduced, with commercial knowledge and tact, energetic and persevering, thoroughly respectable and trustworthy.—Address, stating age and experience, to T. E315, Messrs. Hasenstein and Vogler, A.G., Dresden, Germany. 2268

Wanted, by a Mechanical Engi-

NEER, an ASSISTANT in carrying out experimental work. Applicant must be good correspondent, familiar with all classes of mechanism, capable calculator, good draughtsman, and with a thorough knowledge of workshop practice. Office one hour from London.—Address, giving full particulars and salary required, to 2340, Engineer Office, 33, Norfolk-street, Strand, W.C. 2340

Wanted, Efficient Representa-

TION in London for the SALE of STAMP BATTERIES. Good opening for capable man or firm; practical preferred; give full particulars.—Address, P986, Engineer Office, 33, Norfolk-street, Strand, W.C. P986

Wanted, Foreman Boilermaker;

must be well up in marking off all kinds of work. Good disciplinarian. Must also be able to do plating and fire-work if required. State wages required and experience.—Address, 2286, Engineer Office, 33, Norfolk-street, Strand, W.C. 2286

Wanted, Foreman of Turnery

in Engineering Shop; used to piece-work; one with some American experience preferred.—Address, giving references, stating age and wages required, 2354, Engineer Office, 33, Norfolk-street, Strand, W.C. 2354

Wanted for Leeds, Liverpool,

Cardiff, and the Eastern Midlands, including the East Coast, RESIDENT REPRESENTATIVES for the SALE of a new FUEL ECONOMISING APPARATUS entirely unique in its application. Applicants must combine the knowledge of practical engineers with good experience as salesmen, and be able to take charge of fitters on installation work if necessary. Salary, commission, and expenses.—Apply, enclosing copies only of any recent testimonials, to CHIEF ENGINEER, Makins Limited, 5, Victoria-buildings, Manchester. Q233

Wanted, Thoroughly Com-

PETENT DRAUGHTSMAN, well up in getting out quantities for and designing lighting and power installations, high speed engines, &c., by a Firm of Electrical and General Engineers.—State fully experience, age, and wages required, to J. H. D., 70, Attercliffe-road, Sheffield. 2171

Wanted, Two Experienced Fore-

MEN PLATELAYERS.—Apply, stating wages required, to W. P. POWELL and CO., Ltd., Hirwain, Glamorganshire. P937

Wanted, Working Foreman over

Turners, Planers, and Drillers, to take entire charge of and arrange men for night shift only; about 20 hands; must be used to high-class small engine work, and thoroughly experienced in arranging night-shift work.—Address, stating age, experience, and wages expected, to 2279, Engineer Office, 33, Norfolk-street, Strand, W.C. 2279

Wanted, Works Foreman, accus-

TOMED to the manufacture of Incandescent Electric Lamps.—Reply, giving experience, &c., by letter, S. F., care of J. W. Vickers, 5, Nicholas-lane, E.C. 2327

Water Meter Inspector Wanted

to Fix, Inspect and Repair Water Meters; must be a steady and trustworthy workman, and have had considerable experience. Wages about 30s. weekly.—Apply, stating full particulars as to age, experience, &c., to F. W. TALBOT, The Waterworks, Frimley Green, Surrey. 2321

Works Assistant Wanted by

the LANCHESTER ENGINE CO., Sparkbrook, Birmingham; must be well up in modern machine tool work.—Apply in first instance by letter, stating previous experience, qualifications, and salary required. 2287

Works Manager Wanted to

undertake the General Management of Engineering and Hydraulic Works. The position is one of some importance, and only men of first-class ability need apply. Give fullest particulars, references, and mention age and salary required.—Address, 2332, Engineer Office, 33, Norfolk-street, Strand, W.C. 2332

A Firm of Railway Engineers

and Ironfounders invite APPLICATION from Gentlemen having a good connection with railway representatives and others using railway materials to REPRESENT them in London.—Address, 2275, Engineer Office, 33, Norfolk-street, Strand, W.C. 2275

Appointments as Inspectors of

WEIGHTS and MEASURES may be obtained by persons over 21, who will qualify for Board of Trade Exam. Salaries £100 to £350 a year.—Write for particulars to INSPECTOR of WEIGHTS and MEASURES, Oakham, Rutland. 36

Blast Furnace Manager Wanted

for Scotch Ironworks.—Applications, stating age and experience, to be addressed to MANAGER, Wm. Portcous and Co., Glasgow. P960

Cost Department. — A Smart,

intelligent MAN, age about 25, is WANTED to ASSIST in the above Department in a medium sized Engineering Works in Leicester. The chief qualities required are thorough reliability, application to duty, and organising ability. One who has had all-round experience in office of a small engineering works preferred. An improving position is offered to the right man, and it is requested that none except those who meet the above description will apply. Applications to state full experience, age, and salary required, and to be accompanied by copies of testimonials. Applications to be marked "Cost."—Address, 2199, Engineer Office, 33, Norfolk street, Strand, W.C. 2199

Draughtsman. — Good Man

WANTED for Electrical Work, with practical experience prefered.—Apply, stating age, salary, and experience, to D. O., Crompton and Co., Limited, Chelmsford. 2328

Draughtsman Required; Must

be thoroughly experienced, and capable of Supervising Erection of Machinery.—Apply, stating age, references, and salary required, to SUSSEX PORTLAND CEMENT COMPANY, LIMITED, Newhaven. 2276

Draughtsman Wanted, accus-

tomed to Bridges, Roofs, and Constructional Iron and Steel Work.—Apply, stating age, experience, and salary required, to HEMINGWAYS, LIMITED, Haverton-hill, Middlesbrough. 2261

Draughtsman. — Wanted at

once, first-class MACHINE TOOL DRAUGHTSMAN. Good salary and permanent situation to really first-class man accustomed to machine tool designing; but none other need apply.—State age, experience, salary, &c., to 2269, Engineer Office, 33, Norfolk-street, Strand, W.C. 2269

Draughtsman Wanted, Experi-

enced in Steam Engines, Pumps, and General Engineering Work; must be accurate in taking out weights for estimating, and reliable in every way.—Address, stating age, experience, and salary required, 2253, Engineer Office, 33, Norfolk-street, Strand, W.C. 2253

Draughtsman Wanted in London,

accustomed to designing and estimating steel roof work, buildings, floors, and general constructional work.—Apply, with particulars of experience and salary, &c., to H., care of T. W. Hannaford, 57, Ludgate-hill, London, E.C. 2309

Draughtsman Wanted; One with

experience in Elevating and Conveying Machinery, Colliery Plant, and Structural Ironwork.—Apply, stating age, wage, and experience, and when at liberty, to GRAHAM, MORTON, and CO., Black Bull-street, Leeds. 2330

Draughtsman Wanted, who can

Take Charge of alterations, repairs, and extensions in a medium-size Tool and Engineering Works in Sheffield; must be expert in costs and estimates. State age, full experience, and salary required.—Address, 2300, Engineer Office, 33, Norfolk-street, Strand, W.C. 2300

Foreman Erector Required for

an Engineering Works in London; must have had large experience in the management of men; well up in modern shop practice. State age, qualifications, and send copies of testimonials in confidence.—Address, P967, Engineer Office, 33, Norfolk-street, Strand, W.C. P967

Foreman Fitter and Millwright

WANTED, to take charge of Fitters and Machinery, in large Ironworks and Forge.—Address, C. D., care of J. W. Vickers, 5, Nicholas-lane, E.C. 2243

Foreman of Smiths and Fitters

REQUIRED for London works, about fifty men; must be thoroughly efficient, and good timekeeper. State age, full particulars of past employment, and wages required.—Address, P907, Engineer Office, 33, Norfolk-street, Strand, W.C. P907

Foreman Turner Required for

an Engineering Works in London; must be well up in jigs and templets for repetition work. State age, qualifications, and send copies of testimonials in confidence.—Address, P968, Engineer Office 33, Norfolk-street, Strand, W.C. P968

Foreman Wanted for Engineer-

ING SHOPS in Midlands, employing about 150 men; must be six o'clock man.—Address, stating experience, age, references, and wages asked, 2133, Engineer Office, 33, Norfolk-street, Strand, W.C. 2133

General Manager Wanted, to

Take Charge of a large Timber Estate and Plantation in South America, on high ground and healthy situation. An Englishman with commercial training, and with knowledge of Spanish and engineering, preferred.—Apply, by letter, stating age, experience, and salary required, to TROPICS, care of Bates, Hendy and Co., 81, Cannon-street, E.C. 2307

Inspector Wanted for Hydraulic

MAINS and MACHINERY. Must be used to the control of men, and not object to night work. Age not to exceed twenty-eight years.—Apply, by letter only, to the SUPERINTENDENT, London Hydraulic Power Company, 46, Holland-street, Blackfriars, S.E. P990

Junior Draughtsman Wanted

by FIRM of ENGINEERS in the North of London.—Address applications, stating salary required, to 2362, Engineer Office, 33, Norfolk-street, Strand, W.C. 2362

Machine Tools.—Wanted, by

large firm of machine tool makers, CHIEF DRAUGHTSMAN; must be a first-rate designer, and thoroughly experienced in every way; should be capable of taking entire charge of an office employing about twenty-five draughtsmen. Liberal salary to suitable man. Applications will be treated in strict confidence.—Address, 2202, Engineer Office, 33, Norfolk-street, Strand, W.C. 2202

Representative Wanted by

leading Firm of Wire Rope Manufacturers for Yorkshire, Derbyshire, and Nottinghamshire. — Address, 2086, Engineer Office, 33, Norfolk-street, Strand, W.C. 2086

Storekeeper Wanted for an

engineering firm in East End of London; hours 6 a.m. to 5 p.m.; must be able to keep simple accounts; wages 30s. per week.—Address, 2303, Engineer Office, 33, Norfolk-street, Strand, W.C. 2303

Tracer Wanted, with Electrical

Experience preferred.—Apply, stating age, salary, and experience, to D. O., Crompton and Co., Limited, Chelmsford. 2329

The National Boiler and General

Insurance Co., Ltd., 22, St. Ann's-square, Manchester, REQUIRE an Additional ASSISTANT ENGINEER for the Consulting Engineering Department; age about 25 to 35; must have good shop and drawing-office experience, particularly in modern steam engines, also good theoretical training; salary to commence £150 per annum.—Address, by letter only, marked "Engineer," giving age, outline of experience and studies, and copies of testimonials, EDWARD G. HILLER, Chief Engineer. 2260

Young Man Wanted as Cost and

WAGES CLERK by Firm in South of England employing about 60 hands. Give full particulars, including age, experience, references, and wages.—Address, P982, Engineer Office, 33, Norfolk-street, Strand, W.C. P982

Wanted, Appointment as Con-

TRACTOR'S AGENT and ENGINEER, either at home or abroad; fifteen years experience on railway and waterworks construction, tunnels, masonry, earthwork, &c.; would be willing to invest some capital; M.I. Mech. E., age 39.—Address, P985, Engineer Office, 33, Norfolk-street, Strand, W.C. P985

Wanted, Opening as an Assistant

to ENGINEER or in DRAWING-OFFICE, in Manchester district. Engine and tool experience. Highest references.—Address, P986, Engineer Office, 33, Norfolk-street, Strand, W.C. P986

Wanted, to Apprentice a Lad to

a good General Engineering Firm; a bonus is offered for satisfactory introduction.—Address, P969, Engineer Office, 33, Norfolk-street, Strand, W.C P969

Wanted, to Apprentice a Youth

(16) to the Gas Engine and General Engineering.—State premium and all particulars to W. R. TAYLOR, The Lamb, Abergavenny, Mon. 2114

A Gentleman, with 20 Years'

experience in engine, boiler, and ship repair accounts, and estimating for same, with shop and office experience, brilliant and up-to-date qualifications, will SHORTLY BE AT LIBERTY. Would Take Charge of Repair Department, control office, or assist manager.—Address, P983, Engineer Office, 33, Norfolk-street, Strand, W.C. P983

Advertiser, with Degree in

Engineering, WANTS to GAIN SHOP EXPERIENCE with view to go in for electric traction; well up in theory and designing; premium, if any, must be small.—Address, P975, Engineer Office, 33, Norfolk-street, Strand, W.C. P975

As Representative or Traveller for

FIRM of ENGINEERS.—GENTLEMAN with experience in these capacities is OPEN to RE-ENGAGEMENT; good technical knowledge; good appearance and address; excellent references; age 42.—Address, P952, Engineer Office, 33, Norfolk-street, Strand, W.C. P952

Assistant Draughtsman Requires

SITUATION; eight years' shop and drawing-office experience.—Address, P966, Engineer Office, 33, Norfolk-street, Strand, W.C. P966

Civil and Mechanical Engineer,

single (33), with 17 years' experience in railway work at home and abroad, survey, construction, &c., English and American methods, SEEKS RE-ENGAGEMENT as Resident Engineer or Works Manager. Has acted as chief engineer on large foreign railway, and thoroughly understands management and control. Speaks French, Spanish, and Hindustani.—Address, P971, Engineer Office, 33, Norfolk-street, Strand, W.C. P971

Designs in Iron and Steel

WORKED OUT at moderate charges.—Address, P954, Engineer Office, 33, Norfolk-street, Strand, W.C. P954

Draughtsman (33), Pumps,

presses, turbines, mill gearing, stone and marble machinery, brass and coppersmith. Served in shops. Also efficient bookkeeper.—Address, P977, Engineer Office, 33, Norfolk-street, Strand, W.C. P977

Electrical Engineer Seeks Situa-

TION; thorough all-round practical experience, designing, erecting, and running steam, gas (Town and Dowson), and water-driven plant; continuous and alternating; well used to motors, accumulators, &c.—Address, P914, Engineer Office, 33, Norfolk-street, Strand, W.C. P914

Engineer and Draughtsman

(28), Civil and Mechanical, DESIRES POSITION, home or abroad. Surveyor; commercial experience and works management.—Address, P999, Engineer Office, 33, Norfolk-street, Strand, W.C. P999

Engineer Desires Appointment;

eight years' experience in leading engineering works; used to outside work.—Address, P963, Engineer Office, 33, Norfolk-street, Strand, W.C. P963

Engineer Desires Appointment

in Hotel, Institution, or any Position of Trust; 8 years hotel experience as chief with hydraulic lifts, electricity, well work, &c.; good references.—Address, P995, Engineer Office, 33, Norfolk-street, Strand, W.C. P995

Engineer, Residing in Dublin,

experienced in steam, agricultural, electric plant, &c., DESIRES to REPRESENT an ENGINEERING FIRM. Good references.—Address, P981, Engineer Office, 33, Norfolk-street, Strand, W.C. P981

Engineer, &c., Wants Appoint-

MENT, with five years' experience drawing-office, five years in shop on machine tools, engines, &c.; just returned from Germany; excellent references.—Address, P997, Engineer Office, 33, Norfolk-street, Strand, W.C. P997

Engineer (29), with Seven Years

experience of pumping, ventilating, and hydraulic machinery, DESIRES APPOINTMENT at home or abroad; could invest a few hundred if required.—Address, P956, Engineer Office, 33, Norfolk-street, Strand, W.C. P956

Engineer (30), Late Outdoor

manager of bridge works, experienced draughtsman, REQUIRES ENGAGEMENT; used to management of men; speaks French and German; good references.—Address, P957, Engineer Office, 33, Norfolk-street, Strand, W.C. P957

Engineer (38) Desires Change,

responsible position; large experience, mechanical and structural; steam, gas, oil engines, and several specialities; best modern practice; theoretical, practical, commercial, estimating; control of men.—Apply, by letter, to A. B., care of Street's Agency, 5, Serle-street, London. 2313

Fitter Wants Situation in

London; steady young man; had ten years' general experience; four years' last place; moderate wage to start.—ENGINEER, 226, Southampton-street, Camberwell, S.E. P994

Foreman Engineer (38) Desires

ENGAGEMENT; energetic, up to date; varied experience; high-class engines and machine tools; first-class testimonials; non-society.—P984, Engineer Office, 33, Norfolk-street, Strand, W.C. P984

Foreman, Fitters and Machines,

WANTS POSITION, energetic, large experience Corliss, winding, hauling, pumping engines, air compressors, and general engineering; age 41; non-society.—Address, P996, Engineer Office, 33, Norfolk-street, Strand, W.C. P996

Foundry Foreman (First-class)

DESIRES CHANGE; thoroughly practical in all branches; good disciplinarian and steady timekeeper; 10 years' reference as foreman; well up with brass and iron mixtures.—Address, P961, Engineer Office, 33, Norfolk-street, Strand, W.C. P961

Foundry Foreman is Open to an

ENGAGEMENT, well up in general engineering work, green, dry sand, and loam, plate, machine, and difficult castings; good timekeeper; non-society; excellent testimonials; age 40; wages moderate.—Address, P967, Engineer Office, 33, Norfolk-street, Strand, W.C. P967

Marine Engines. — Practical

ENGINEER and DRAUGHTSMAN is prepared to SUPPLY working and general DRAWINGS for small compound or triple surface condensing types.—Address, 2347, Engineer Office, 33, Norfolk-street, Strand, W.C. 2347

Mechanical Engineer of Great

experience, and good commercial knowledge, is OPEN to ENGAGEMENT; accustomed to direct general machine, boiler, and foundry work, also to make estimates for machinery, in general, making out quantities of material required, to prepare working and original drawings. Fluent Spanish and German. Six o'clock man; non-society. Highest references.—Address, P974, Engineer Office, 33, Norfolk-street, Strand, W.C. P974

Private Work Wanted by Experi-

ENCED ENGINEER, late with one of the best-known firms. Architects' and engineers' ironwork plans and schemes worked out or checked. Calculations verified. Drawings, plans, and tracings made and copied. Strictest secrecy guaranteed. Help of every kind rendered in any locality.—Address, P993, Engineer Office, 33, Norfolk-street, Strand, W.C. P993

South African Representation.—

IRON and STEEL CONSTRUCTION, MACHINERY, ENGINEERING, IRONMONGERY, &c.—A Gentleman, 18 years' Colonial experience, about leaving for Africa, DESIRES to REPRESENT FIRMS in above lines as Buying or Commission Agent. London references.—FAWCETT, 4, St. Mary Axe, E.C. 2285

Supt., Desirous of Obtaining a

SITUATION as SUPT. of a first-class ironfoundry, doing any kind of work, has been very successful in the United States, can produce references from past and present employers, also records of work done. With a large knowledge of all kinds of iron-mixing, both from chemical analyses and practical use, to bring out best results; also the most modern methods for economical foundry practice.—Address, THOS. FERGUSON, W. Porteous and Co., Glasgow. P970

An Engineering Electrical Firm

has VACANCY for YOUNG GENTLEMAN PUPIL in London works. Permanent employment on qualifying. Premium £20 down, balance by instalments £8 each. Small wages. References given. Board residence 12s. weekly if desired. Similar vacancies in Provinces.—Box C., 78, Temple-chambers, City.

Engineering Pupil. — Firm

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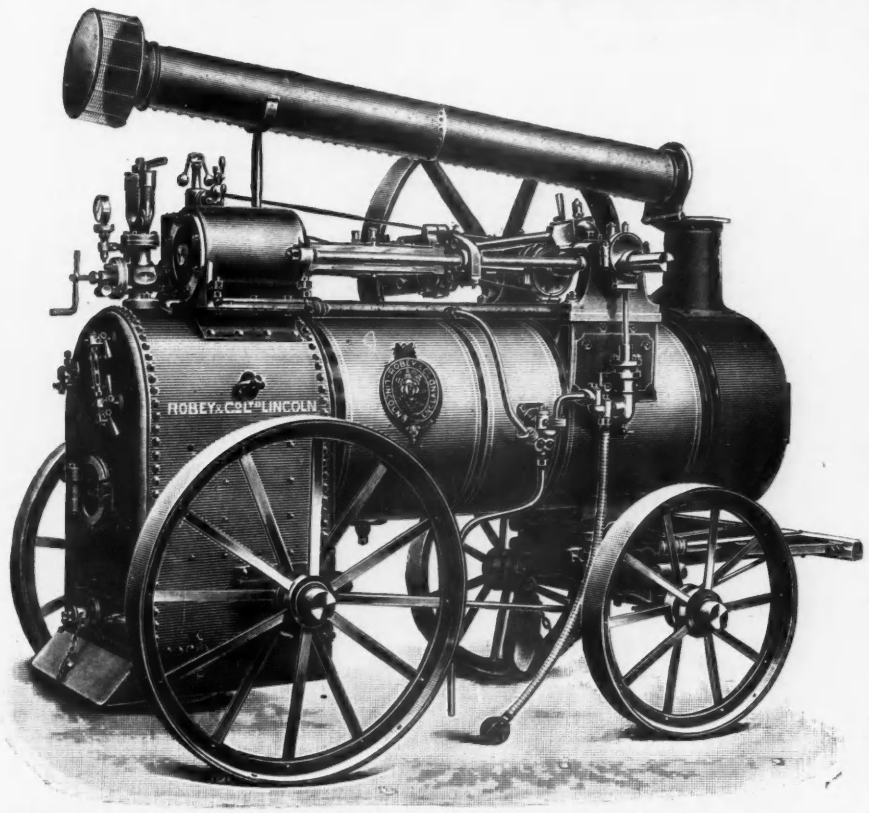

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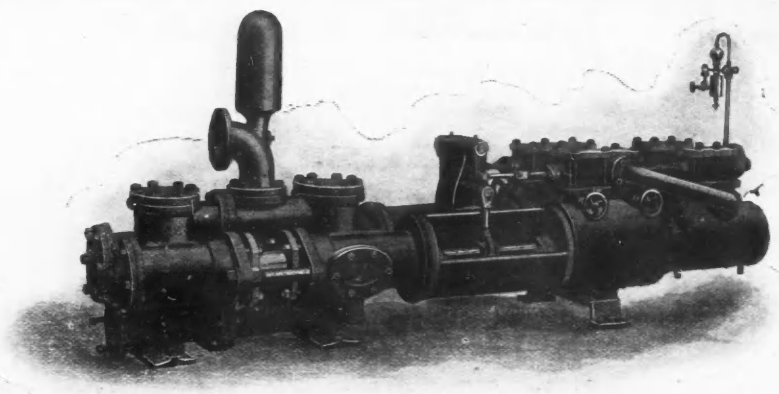

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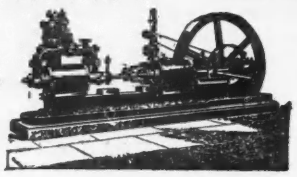

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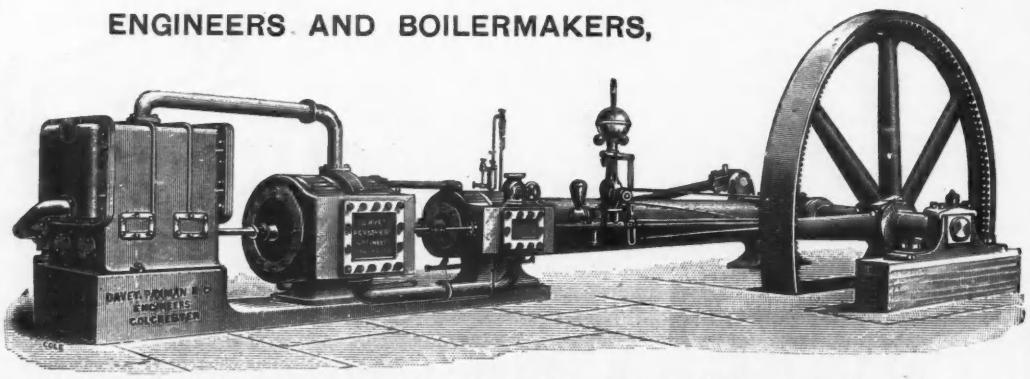

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